PCC-III Controller

Instruction Manual

Instruction Manual
Part Number:
90082

Revision 2.3
1/13/03

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WARNING

The PCC-III is commonly used to control potentially dangerous Combustion and Chemical Processes.

Only qualified Instrument Engineers or Senior Technicians that have read this entire manual, and are familiar with all aspects of the Process being controlled should attempt to re-configure the Blockware Control Logic contained in the memory of a PCC III Controller.

VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) BEFORE MODIFYING ANY OF THE BLOCKWARE DATA IN ANY BLOCK IN THE PCC-III MEMORY.

FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

Note: Rev 2.3 Instruction Manual changes are indicated by a vertical line in the left margin.

Summary of Rev 2.2 Changes:

- Added UL508 screw tightening Caution Note.
- Enhanced the Retentive Memory Comments and Specifications.
- Corrected Spare Parts part number errors.
- Revised OPLR Function description to reflect ROM changes.
- Added “Installing Front Panel Legends” section.
- Added “Supported Modbus Functions” section.

Summary of Rev 2.3 Changes:

- F83 TOUT revised per ROM 3.04
- F84 TCODE added per ROM 3.04
- F100 TTRIP added per ROM 3.04

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INTRODUCTION

The PCC-III represents the next generation of digital controllers in that it maintains all of the advantages of single or multiple loop controllers while addressing many of the features of PLCs and DCS I/O modules.

The substantially shorter mounting depth (will fit in 8" deep panels); NEMA 13 splashproof front panel; standard RS-485 communications facility ("Modbus" protocol); and RS-232/laptop as well as front panel configuration capabilities are certainly readily apparent differences between itself, its predecessor the PCC-II and its competitors. In addition we have retained and in fact enhanced many of the features that customers have come to appreciate about our digital controllers … "Service Manual"; "Learn" function; "Boiler Efficiency" function; "OPLR" Stack Exit Correlation for Opacity Monitors function (new); Oxygen Sensor Temperature Controller and O2 signal conversion option card (new) ….

But It is the flexibility of the PCC-III, not simply as measured by its ability to function without its front panel, but more importantly its I/O expansion capabilities and the significant number of choices available for expansion that render the PCC-III an unparalleled choice for any control application. Consider that each PCC-III CPU board has two expansion board slots each of which is able to harbor any of the available option cards (Note: a third spot is available but is dedicated for use with only one type of option card). Consider further that there are option cards which can…

- Control the temperature of Oxygen Sensors and convert their millivolt outputs to signals useful for control and/or monitoring applications

- Accept as inputs or output analog signals in per option card combinations ranging from 5AI to 3AI/2AO to 4AO to 2 "Isolated" AI…

- Accept as inputs or output discrete signals in per option card combinations ranging from 8DI to 4DI/2RO to 4RO …

- As noted the ability to install the PCC-III CPU board alone (i.e. less front panel) …DCS-III… with or without any of the combination boards mentioned above further enhancing Data Acquisition and control capabilities.

So as you read this manual, be sure that you are clear about the vast capabilities of the PCC-III. It is simply not just another digital controller.

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Product Description

This section overviews the PCC-III features which address the requirements of both Data Acquisition and control applications. The PCC-III is designed to address the needs of most process control applications and that design has been further optimized to meet the exacting needs of combustion control systems.

Features	Benefits
Multiple Loops	Allows cost effective control of more than one process loop in a single controller.
Service Manual	Allows “Manual” control in the event of memory, CPU, or digital circuitry failure.
Redundant Memories	Allows for “self recovery” in the event of a primary memory error.
Optically Isolated Data Highway	Safe/reliable communication that prevents a single controller failure from disrupting an entire network. Redundant RS-485 communications are available as an option.
Engineering Units Display Flexibility	Allows the operator to view up to 10 process variables each with process (tag) descriptions.
Local Blockware Configuration	Allows front panel Blockware configuration without the need for a special configurator or laptop computer. Note: a standard RS-232 port allows laptop configuration as an alternative.
Ten point (“first in-first out”) Alarming	Allows the operator to view the order of alarms and acknowledge each separately.
“Learn” Function	Allows for easy entry of complex function curves without prerequisite data collection.
Industry standard communications	Allows the controller to be used in any system and/or with others hardware/software which communicate via “Modbus” protocol.
Optional I/O Cards	Allows significant Discrete and Analog I/O expansion capabilities within a single controller.
Self-supporting CPU Board	The controller’s CPU board is fully functional without the front panel, allowing for further I/O expansion alternatives.

Distributed Control System Concepts

The PCC-III represents the third generation of process controllers from Preferred Instruments. This controller is designed to provide a true distributed approach to control applications. The PCC-III provides automation features that are self sufficient and will operate independently of the remainder of the control system. The PCC-III can be configured as a data collection I/O module (DCS-III) for a data acquisition system, as a multi-loop controller or as a traditional single loop controller. In all cases the PCC-III will communicate on a network with a central operator's station using the industry standard "Modbus" protocol.

Because the PCC-III is self sufficient, control will be maintained even if for any reason, the operator's station(s) or network are completely disabled. Further, even if the internal microprocessor or digital electronics of the PCC-III fail, a "hard manual" option card will allow the process to be manually operated. Lastly, much like a DCS or PLC I/O card, a complete PCC-III or DCS-III failure affects a relatively small percentage of the overall system's I/O. Considering all the above, the need for redundant power supplies, microprocessor cards, or I/O cards is all but eliminated.

The backbone of the system is the network. The network used between controllers is based upon the industry standard "Modbus" protocol, using the controller's integral RS-485 communications facility. This network communications is optically isolated and can be made redundant (optional).

Analog and PLC Control Functions

The PCC-III includes all the control functions needed for your application. The controller includes not only traditional analog functions but also many discrete (logical) and timing functions. The controller can handle many tasks that would normally require the use of a PLC and the use of option cards permits expansion of those discrete I/O capabilities (up to 13 DI and 10 RO/DO). Discrete functions can also be readily integrated with analog functions which has been traditionally difficult to accomplish with a PLC due to its purely logical basis. The combination of integral analog, discrete and timing functions renders the PCC-III a very powerful control solution.

Configuration Concepts

In most applications the PCC-III is shipped with a factory configuration, but it is designed to permit easy modification or development of control strategies in the field. The PCC-III can be completely configured using front panel keys and the digital and alphanumeric displays. The configuration is managed using easy to follow menus that are controlled by keys on the front panel (Note: these keys are normally locked out with switches that are located behind the front panel to prevent unauthorized use). The keys allow for field modification or development of configurations without the use of any other devices such as special configurators or laptop computers that may not be readily available. An RS-232 port is however available to allow the use of a PC computer as a configuration tool. The PC also permits the downloading and retrieval of stored configurations and full documentation of same.

Com-Link Data Highway Concepts

The PCC-III can be networked together over an industry standard "Modbus" network. "Modbus" is an open architecture format to allow flexibility for future system expansion and/or modification. This network is optically isolated and makes use of a single pair of wires. The network allows controllers to be located up to 4000 feet part and up to 31 controllers (plus the "Master") can be coincidentally networked. The use of "Modbus" as a communications protocol allows the PCC-III to be integrated with other's equipment and on networks supplied by ourselves or others. The "Modbus" communications facility is the industry standard RS-485.

Blockware Concepts

The PCC-III makes use of “Blockware” which we believe makes control strategy configuration easier. In **Section 5**, we will discuss “Blockware” and configuration in greater detail but the basic elements that make up “Blockware” are as follows:

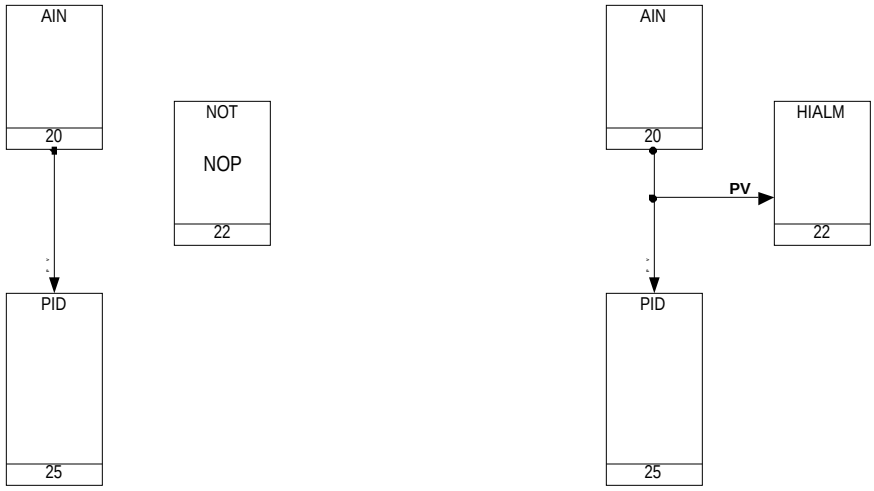
Blocks
The PCC III memory has 160 Blocks. Each Block is a container that a Blockware Function is put into. Think of a Block as a “cell” in an Excel or Lotus 1-2-3 spreadsheet, you put a formula or a function into a cell, and the formula uses the values from other cells as “Inputs” for the formulas. Another analogy would be physical relay sockets that have signal processing modules plugged into each socket (ie, Block). The controller includes sufficient memory to handle 160 Blocks.

Library of Functions
The PCC-III has an extensive library of Functions to handle any type of control task. These Functions are identified and described in detail in Section 6 of this manual. The library includes Functions for the conversion of Inputs to engineering values, mathematical operations, logical operations, timing operations, the traditional PID algorithm as well as other types of special **PID** Functions. Additional special Functions such as “Learn”, “Boiler Efficiency”, etc. are also included and are described in depth in Section 6.

Any-Function-Any-Block
Each Block is assigned a “Function type” during configuration. Any “Function type” can be used in any Block number. The “Block number” only determines the order in which the Blocks are calculated. In the example below at left, Block number 22 is not being used, so it has the default **NOP**, or “**N**o **OP**eration” Function in it. At Right , Block 22 was changed from a **NOP** to a **HIALM** (high alarm) Function type.

Reusable Functions
Almost all PCC III “Function types” can be used as many times as required, within the 160 Block limit. There are some Functions that are directly linked to the hardware that can only be used as many times as there is mating hardware. For example, only one **PANEL** Function (Front Panel Display Interface) can be used because there is only one Front Panel. While those related to **PID** Functions, curve fitting Functions, etc. can be used as many times as is deemed necessary for the application.

Softwiring
Most Function Types, like **HIALM,** need information from other sources (ie, Blocks) in order to calculate a result. Softwiring is the term used to describe how the Blocks are interconnected within the software. Softwiring allows the Input of a Block to monitor the Output of any other Block. At right below, the PV (Process Variable) Input of Block 22 (**HIALM**) is monitoring the Output of Block 20 (**AIN**), via a Softwiring connection.



Special Option Card and Special "Function Block" Capabilities

The following are applications features of the PCC-III which extend its capabilities considerably:

Multiple F(x)

The F(X) "function type" allows for "characterizing" or "curve fitting" of a relationship when that relationship is non-linear. In combustion control applications, as an example, it is desirable to have the "fuel input" to a burner follow a linear relation with "firing rate demand". Even with a properly selected valve trim, the relationship will not be perfectly linear. But with the application of an F(X) block this objective can be realized. The PCC-III has the capacity to use as many F(x) functions as are required by the application. In some complex combustion applications a single controller may use up to 6 to 8 F(x) functions.

Learn Mode

The "Learn Mode" allows for easy commissioning of applications involving single or multiple non-linear functions. This capability is best described with an example… in combustion control applications, as the firing rate is increased, the best combustion air damper position will likely not be a linear function. An F(X) block can be used to effectively linearize the "combustion air flow vs. firing rate" relationship. F(X) blocks will likely be required for the "fuel valve degree of opening" demand signal and the "Oxygen Setpoint" as well (if O2 Trim is provided)… The clear benefit of the "Learn Mode" is that at each of the 10 available F(X) Block data points, after optimum conditions are set by the technician, he/she simply presses the "Learn" button for the PCC-III to remember ("Learn") the current firing rate vs. valve and damper positions and "Oxygen Setpoint" relationships simultaneously. The technician then proceeds in a similar fashion up to full firing rate, repeating this procedure at each point. This results in a considerable savings in commissioning time, as well as an optimally "characterized" process.

Boiler Efficiency

The Boiler Efficiency function allows the controller to calculate, in real time, the boiler's efficiency and display that result on the controller's front panel (and/or a recorder or a Data Acquisition terminal). Boiler Efficiency is calculated using the ASME "by losses" method. This function requires inputs of flue gas temperature, combustion (ambient) air temperature, percent oxygen in the flue gas, and percent firing rate (for Radiation Loss determination) to evaluate the efficiency. This function is not only useful for establishing "on-line" fired equipment efficiency, but as a result allows determination of changes in that efficiency and therefore the potential for maintenance.

Service Manual (option card)

The optional "Service Manual" feature allows the operator to manually adjust the controller's output in the event of a failure of the controller's microprocessor, power supply, memory or any digital circuitry. In the event of such a failure, the output will remain at its "last position" until such time as the operator changes that position.

Triac Output for Electric Actuators (option cards)

Many systems utilize electric actuators where a bi-directional "on-off" voltage signal is used to drive the actuator open or closed. The PCC-III has the optional interface electronics to accomplish this control action. Additionally the Triac Output option card(s) include "position feedback" input provisions for optimizing control of actuator position.

Steam Flow Pressure Compensation

Accurate steam flow measurements are very important to the control and monitoring of process systems. Even though most control systems are designed to assure a constant pressure, variations and/or upsets can occur, which if unaccounted for, can render records erroneous and produce unacceptable instabilities in all control loops upon which this measurement depends.

Gas Flow Pressure/Temperature Compensation

Most gas flow measurements require some level of pressure and/or temperature compensation. This becomes of particular importance when the flow measurement is a significant process control variable as it is in a "fully metered" combustion control strategy.

High Temperature Hot Water (HTHW) BTU/Hr Computation

An important characteristic of any High Temperature Hot Water Generator is the quantity of BTU's produced per interval of time. With inputs of the generator's inlet and outlet water temperatures and the water's flow rate this value can be easily calculated. The resultant figure is typically compared to that from the aforementioned "Boiler Efficiency" calculation to determine if possible problems have arisen.

Drum Level Pressure Vs. Density Compensation
In applications where there are large swings in steam demand, the steam generator's drum level can be subjected to significant "shrink" and "swell". Density compensation is an important tool in assuring optimum drum level control despite these conditions.

Oxygen Sensor Control/Signal Conversion (option card)
Zirconium oxide "in situ" oxygen analyzers include a basic electronics package that maintains sensor temperatures at exacting levels and as well converts the millivolt output of the sensor into a linear "O2 vs. milliamp" function (4-20 madc). When equipped with the appropriate option card, the PCC-III performs the same function as the manufacture's electronics package, while coincidentally allowing for the automatic integration of that variable into any planned control or monitoring strategy.

Relay Output Channels
The PCC-III can be equipped with up to 6 Relay Outputs. The Relay contacts are rated for up to 8A inductive loads and include integral surge suppressors for extended contact life. These outputs can be directly wired into most burner limit circuits without external "helper" relays.

"OPLR" Stack Exit Correlation for EPA Opacity Monitors
EPA certified stack Opacity monitors are required to display the Opacity as would be viewed at the Stack Exit. However, the Opacity Transmissometer (ie, the sensor) is never mounted at that location. The PCC-III includes a "function type" that will calculate the complex EPA mathematical equation to convert (ie correlate) the Opacity measured at the sensor's actual location to that at the Stack Exit.

Flow Totalization
The PCC III is equipped with a Pulse Counter "function type" to permit output and subsequent totalization of flow rates on digital displays. This can eliminate the need for local counters on flow meters in those instances when they already transmit an analog flow signal to the PCC-III.

PCC III Loop Controller Model Number

PCC III - a b c 0

Option Card Slot Number 1

0	none
A	AIN 5 ch. 4-20 mA / 0-5 Vdc
B	IAIN 3 ch. Isolated 4-20 mA / 0-5 Vdc
F	AIN 3 ch. 4-20 mA / 0-5 Vdc AOUT 2 ch. 4-20 mA Combination Board
G	TOUT 2 pair Triac Outputs, 2A 24-120 Vac AIN 2 ch. Pot / 0-5 Vdc / 4-20 mA Combination Board
J	DIN 4 ch. 120 Vac, Optically-Isolated ROUT 2 ch. Relay Contact, 8 A Inductive Combination Board
Z	ZrO2 Oxygen Analyzer Amplifier and Temperature Controller
R	Redundant RS-485 Communications, Optically isolated (Slot 1 only)

Option Card Slot Number 2

	Select card type from the “Slot 1” list above

Option Card Slot Number 3

0	none
S	TOUT 1 pair Triac Outputs, 2A, 24-120 Vac

Option Board Input / Output Expansion Examples:

PCC III Model Number	4-20 mA 0-5 Vdc AIN	4-20 mA AOUT	120 Vac DIN	8A (relay) ROUT	2A (triac pairs) TOUT	200 mA (sinking) DOUT	Total I/O
PCC-III- 0 0 0 0	5	2	5	2	0	4	18
PCC-III- A A 0 0	15	2	5	2	0	4	28
PCC-III- F F 0 0	11	6	5	2	0	4	28
PCC-III- J J 0 0	5	2	13	6	0	4	30
PCC-III- G G S 0	9	2	5	2	5	4	27
PCC-III- F G S 0	10	4	5	2	3	4	28
PCC-III- A J 0 0	10	2	9	4	0	4	29

Note: The examples given in no way reflect the number of possible option card possibilities. The PCC-III has a total of three (3) option card slots, of which one is designated for use by the “S” card only. The remaining two slots can house any of the remaining option cards in any desired combination. Please refer to **Section 5** to establish the total 24 VDC power supply requirements, as some combinations may require installation of an auxiliary power supply

Preferred Instruments

PCC III Controller
Spare Parts List

Part Number	Description	Recommended spares per 10 PCC III's
PCC-III-0000	Complete PCC III controller, with case & mounting brackets	0.5
92227	Main power fuse, 0.3A slo-blo	2.0
92233	Ribbon cable assy., door to CPU board	1.0
	Available Spare Parts:	
190315	CPU board	
99595	Backup Memory Module, 8kx8 EEPROM	
92204	8 pt. field wiring connector	
92223	14 pt. field wiring connector	
92076	Slide-on jumper (250 ohm & R/W)	
2759-006A-08C	CPU to case retainer screw, 6-32 x 1/2	
190349	Front Panel,complete, includes: Bezel, keyboard, display board, cable, Edit keys door	
90137	Front Panel screw with integral O-ring	
90140	Front Door gasket	
190358	Front Panel with Keybord, less display circuit board	
190316	Front Panel display circuit board only	
2759-006A-03Z	Front Panel display circuit board mounting screws, 6-32 x 3/16	
90136	Blank engravable nameplate for Front Panel	
190348	Case for panel mounting with rear cover (190347 panel mounting brackets not included)	
90134	Case to panel gasket	
190347	Panel Mounting Bracket Kit (2 brackets/kit)	
190319	1 pair Triac output option board (slot 3 only)	
92245	5 pt. field wiring connector	
92247	fuse, 3 A, fast acting	
190361	5 ch. 4-20 mA / 0-5 Vdc AIN option board	
92243	12 pt. field wiring connector	
190362	3 ch. 4-20 mA / 0-5 Vdc isolated AIN option board	
92251	6 pt. field wiring connector	
190366	3 ch. 4-20 mA / 0-5 Vdc AIN, 2 ch. 4-20 mA AOUT combination option board	
92243	12 pt. field wiring connector	
190367	2 ch. 0-5 Vdc / pot AIN, 2 pair 3A 24-120 Vac TOUT (Triac) combination option board	
92243	12 pt. field wiring connector	
190370	4 ch. 120 Vac opto-isolated DIN, 2 ch. 8 A ROUT (Relay) combination option board	
92243	12 pt. field wiring connector	
190355	PC3_Edit /_Draw RS232 download cable with DB9 adapter	
25250-0B25-3/4MF	250.0 Ohm Precision Resistor	

PCC-III Specifications

Mechanical:

Case Size:	Height: 7.38"; Width: 3.00"; Depth: 7.75"
Enclosure Type:	Flush panel mounted
Front Panel Size:	8.00" H X 3.75" W
Panel Cutout:	7.50" H X 3.13" W (+/-.062)
Weight:	6 lbs. (excluding option boards)

Environmental:

Operating Temp:	32 to 122°F (0 to 50°C)
Storage Temp:	-20 to 150°F (-28 to 65°C)
Humidity Limits:	15 to 95% (non-condensing)
Front Panel:	NEMA 13, IP65

Performance:

Accuracy:	0.025% Analog Inputs and Outputs, 70 F
Resolution:	16 bit input / 16 bit output
Execution Cycle:	Ten per second
Non-Volitale Memory Life:	10.8-30 yrs, Blockware dependent

Operator Control Panel:

Displays:	
Alphanumeric:	8 character LED (0.2")
Numeric:	4.5 digit LED (0.43")
Bargraph:	
Left/Right:	51 segments LED (5.1")
Output:	20 segment LED (2.1")
Pushbuttons:	Membrane, tactile feedback
Faceplate:	Mylar, splashproof
Alarm Annunciator:	10 Point, First out
Status Indicators:	6 LED, Configurable
User Defined Pushbuttons:	4, Configurable

Electrical:

Input Power Requirements:	120 Vac (+/- 15%), 22 VA
Power Supplies:	24 Vdc @ 215 mA and 5 Vdc @ 50 mA

Input/Output (Standard – no option cards):

Analog Inputs:	Quantity:	5
	Type:	4-20 maDC; 0-5 VDC
Analog Outputs:	Quantity:	2
	Type:	4-20 maDC, 800 ohm load
Discrete Inputs:	Quantity:	5
	Type:	120 VAC opto-isolated
Discrete Outputs:	Quantity:	6
	Type:	(2) SPDT relay contact, 8A, 120V; ½ HP @ 120 VAC
		(4) Open Collector (sinking), 24 VDC, 200mA
I/O Expansion:		See Table Below

Communications

Network:	Protocol:	Modbus (ASCII or RTU mode)
	Speed:	1200-38,400 baud
	Type:	RS-485, optically isolated
Configuration:	Speed:	1200-38,400 baud
	Type:	RS-232 with telephone modular handset connector

Specifications subject to change without notice.

Section 2: Installation

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Option Board Descriptions

Option Board Slot 1 or Slot 2

A	AIN	5 ch.	4-20 mA / 0-5 Vdc	
B	IAIN	3 ch.	Isolated 4-20 mA / 0-5 Vdc	
F	AIN	3 ch.	4-20 mA / 0-5 Vdc	
	AOUT	2 ch.	4-20 mA	Combination Board
G	TOUT	2 pair	Triac Outputs, 2A 24-120 Vac	
	AIN	2 ch.	Pot / 0-5 Vdc / 4-20 mA	Combination Board
J	DIN	4 ch.	120 Vac, Optically-Isolated	
	ROUT	2 ch.	Relay Contact, 8 A Inductive	Combination Board
Z	AIN	3 ch.	mV, Optically-Isolated	ZP Oxygen Analyzer
	TOUT	1 ch.	Triac Outputs, 2A, 120 Vac	Combination Board

Note: The 'Z' Option Board is described in the ZP Oxygen Analyzer Manual, it is NOT covered by this Manual.

Option Board Slot 3

S	TOUT	1 pair	Triac Outputs, 2A, 24-120 Vac

Mounting Overview

PCC III is designed for flush mounting in an enclosure in a NEMA 13 (IP65) indoor environment. Continuous operation is guaranteed over the 32-125 F (0-52 C) ambient temperature range without derating. The controller should not be subjected to excessive vibration. The PCC-III is UL508 recognized for NEMA 1 dry indoor applications. The NEMA 13 rating is based on Preferred Instruments testing and is not third party UL508 recognized.

NEMA 13 / IP65 Environment

A NEMA 13 environment is generally defined as: Intended for indoor use primarily to provide a degree of protection against dust, and splashed or sprayed water, oil, or non-corrosive coolant. NEMA 13 is generally equivalent to the European IEC standard IP65.

The PCC III front panel and case gasketing will provide NEMA 13 protection if the enclosure to which the PCC III is mounted itself is designed for NEMA 13 (minimum) protection.

PCC III can be installed in more severe environments if the user provides additional protection that is consistent with and/or required for the area's rating.

Ambient Temperature

PCC III is rated for continuous operation over the 32-125 F (0-52 C) ambient temperature range without derating. A typical PCC III installation (in a control cabinet mounted next to an industrial packaged boiler) would not require cabinet cooling. However, each installation should be evaluated individually to determine if the PCC III ambient temperature (ie, the control cabinet internal temperature) will exceed 125 F.

The control cabinet internal temperature is a function of the outside air temperature, the surface area of the control cabinet, and the amount of heat released by other components inside the cabinet. A PCC III consumes 22 VA worst case, therefore, it releases a maximum of 75 Btu/hr. The major control cabinet manufacturers (Hoffman, Hammond, …) include information in their catalogs to help calculate cabinet internal temperature rise (with and without various cooling methods).

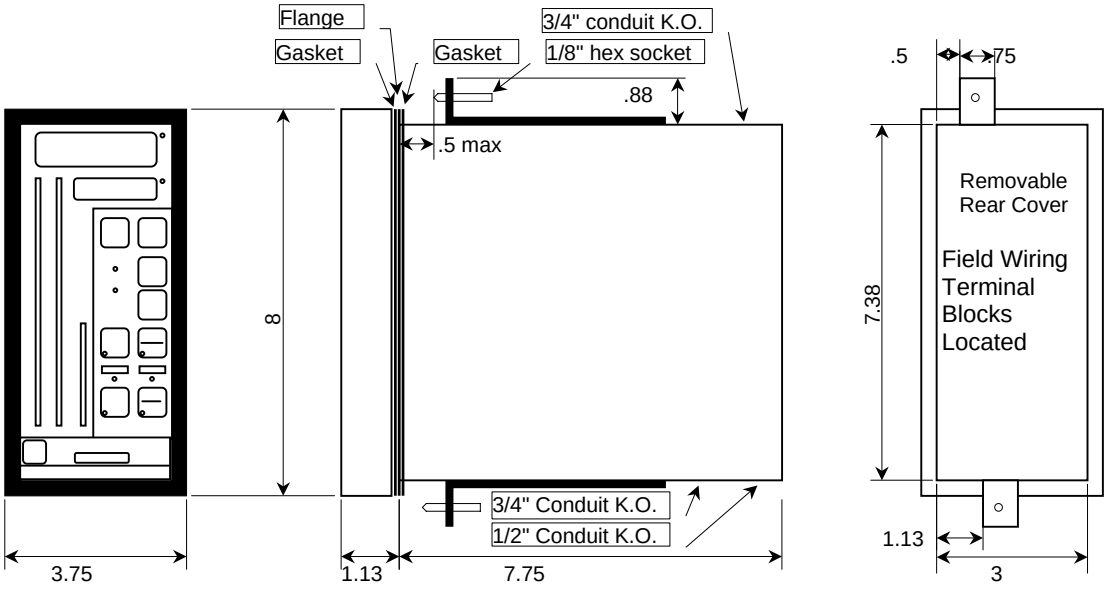
Rear Access

The PCC III case is 7 ¾ " deep behind the mounting flange; therefore, PCC III can be mounted in 8" or deeper control cabinets. All field wiring connections are located behind a cover plate in the rear of the controller. Rear access is required for installation, calibration, and trouble shooting. Routine operation and control strategy Blockware downloading is accomplished from the front of the controller.

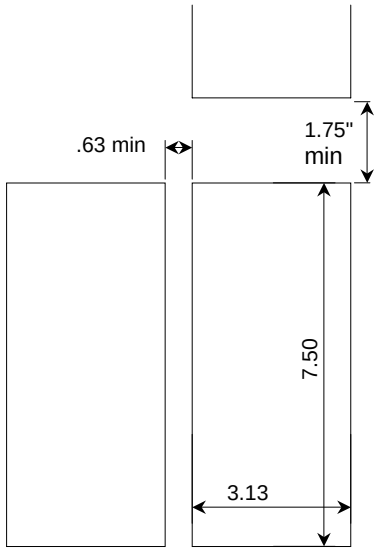
Mounting

Refer to the PCC III Mounting and Panel Cutout Dimension drawings that follow. Cut the hole in the enclosure. Remove any burrs and loose metal chips. Remove the Panel Mounting Brackets from the PCC III case. Slide the PCC III into the hole. From the rear of the PCC III, slide the Mounting Brackets tabs into the slots in the PCC III case. Using a 1/8" Allen wrench, tighten each mounting bracket screw against the enclosure.

Additional Mounting Brackets can be ordered as part number 190347, if the mounting brackets supplied with the PCC III are lost or damaged.



PCC III Dimensions
(inches)



Panel Cutout Dimensions
and Minimum Spacings (inches)

Wiring Overview

WARNING

The PCC-III is commonly used to control potentially dangerous Combustion and Chemical Processes. VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) BEFORE REMOVING POWER FROM THE PCC-III CONTROLLER. FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

WARNING

It is very common to have multiple sources of power among the wires connected to a PCC-III. VERIFY THAT ALL SOURCES OF POWER HAVE BEEN DISCONNECTED BEFORE WORKING ON WIRING. FAILURE TO DO SO CAN RESULT IN INJURY OR DEATH.

All Panel and Field wiring should conform to National and Local Electrical Codes. Typically, NEC (National Electric Code) applies to field wiring; while NFPA 79 and UL508 applies to Industrial Control Panel wiring.

120 Vac Ground

Connect the incoming AC Power Ground (ie "Green Wire" Ground) to the screw and lug marked "GROUND" inside the rear of the case near the bottom of the terminal strips. AC Ground is not connected to DC Common. See "DC Commons and AC Neutrals" on page 2-18.

Terminal Blocks ⚠

(See Field Wiring Label on pg. 2-10)

All Field Wiring terminals are separable, and plug-in to the PC board. This allows rapid board level replacement without disconnecting individual field wires. Verify that Terminals are inserted properly before applying power.

The AC terminals on the CPU board are numbered 1L to 8L and 1U to 8U. The terminals are arranged in two rows of eight. "L" refers to the Lower row, while "U" refers to the Upper row.

Terminals 1L to 8L, 1U to 8U, and 29 to 33 accept 24 – 12 ga. wire and should be tightened to 4.5 in-lb.
Terminals 1 to 28, and 40 to 51 accept 22 – 14 ga. wire and should be tightened to 2.2 in-lb.

Wire Type

All wiring (AC, DC, and shielded cable) should be copper, stranded, 150 V min., and 60° C minimum.

Shielded Cable

All 4-20 mA / 0-5 Vdc Input and Output wiring should be 22 gauge minimum, 85% shield (min.), and have twisted pairs (Belden 8737 or equal). 100% foil shielding is preferable if available.

The shields of all 4-20 mA / 0-5 Vdc cables should be connected at one end only, as shown on the drawings that follow. Generally, the shield is connected to the DC common of the Power Supply that is powering the signal. All shield foils, and shield wires should be insulated (taped or heat shrink) to prevent accidental connection to earth or power ground. Shields connected at both ends, or unintentional second grounds can actually add extra noise to a signal instead of reducing noise. To prevent noise pick-up, shielded cables should never be run in conduits or trays with AC wiring (any voltage). Ignition transformer and variable frequency drive AC wiring is particularly noisy and should be kept separated from all DC signal wiring.

24 Vdc & 5 Vdc Power Supply Load Calculations

The PCC III CPU board has a built-in 24 Vdc power supply that is rated for 215 mA continuous output at 138 Vac and 125 F. The 215 mA current limit is based on the sum of all 24 Vdc loads; CPU board, Option boards, and field (terminals 10, 16, 27, 28). Below is a worksheet to calculate total 24 Vdc current load.

Item	mA each	Qty.	Total
2 wire 4-20 mA xmtrs that are powered by PCC III	20		
4-20 mA Outputs (CPU + "F" board(s))	20		
Relays (CPU + "J" board(s))	25		
"B" Isolated Input board(s)	55		
"G" Triac Board, 24V powers +5Vdc Field wiring load dependent	50 max		
Total mA Load:			

Notes:

1) Only count 4-20 mA Outputs and Relays that are actually being used.
2) Each "B" board draws 55 mA regardless of how many Input channels are being used.
3) Example: a PCC-III-BF00 that is configured to use three 4-20 mA Outputs and 1 Relay Output draws 155 mA internally. Therefore, 60 mA is available for field loads (typically transmitters).
4) **A direct short across the 24 Vdc will blow the PCC III 120 Vac power fuse.** An external 300 mA fast-acting fuse for field +24 Vdc loads is recommended.
5) The CPU has a 5 Vdc / 50 mA power supply for field devives (feedback pots, etc.). Each "G" option board also has a separate 5 Vdc / 50 mA power supply. Note the "G" board 5Vdc current usage subtracts from the available 24 Vdc current.

Fuses

Every PC board in the PCC III that uses a fuse is shipped with one spare fuse attached to the PC board (see drawings on pages 2-7 thru 2-9 for fuse locations). Fuses used in the PCC III include:

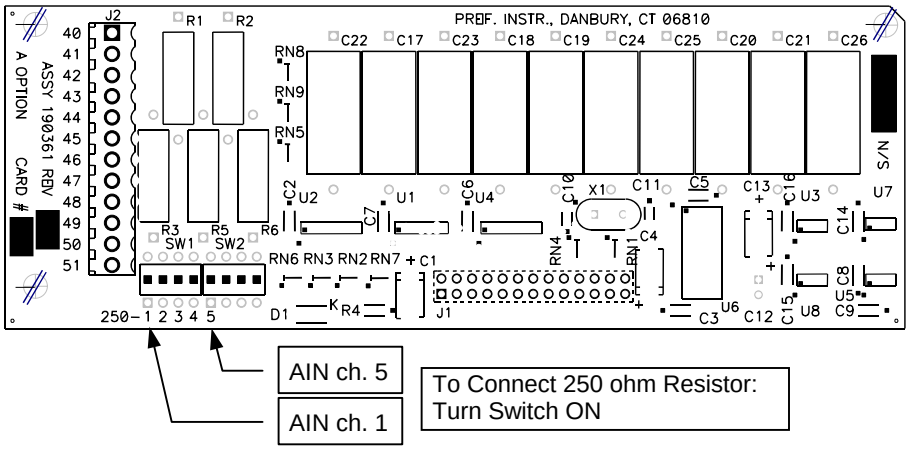
Board	Service	Amps	Type	Preferred Part Number	Littlefuse Part Number
CPU	120 Vac power to +5 and +24 Vdc supplies	0.3 A	Slo-Blo 250 V, 5x20 mm	92227	239.300
"G" and "S" Triac option boards	24-120 Vac power to Triacs	3.0 A	Normal Blow 250 V, 5x20 mm	92247	235.003

250 ohm Resistors for 4-20 mA Inputs

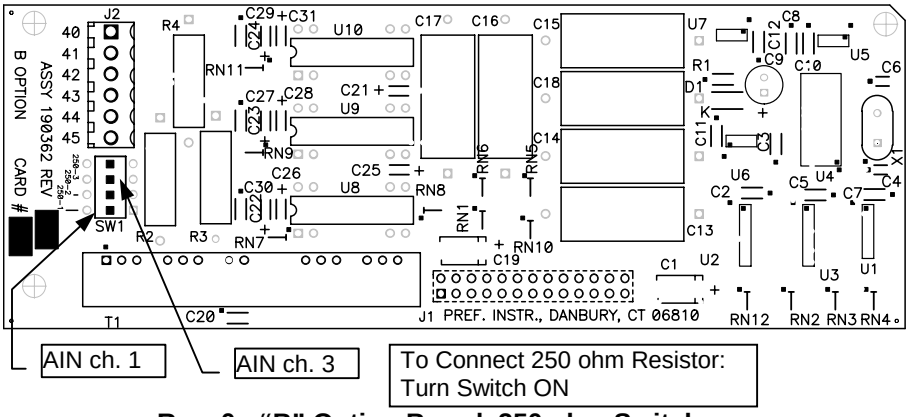
Except for the "G" Option Board, every PCC III Analog Input channel has an internal 250.0 ohm precision resistor that the user can connect to the Input. If connected, the 250 ohm resistor converts a 4-20 mA signal into a 1-5 Vdc signal.

The CPU Board utilizes jumpers that slide onto header pins to connect the 250 ohm resistors to the Inputs. The "A", "B", and "F" Option Boards have DIP switches. See the drawings on pages 2-6 through 2-9 for the locations of the 250 ohm resistor switches and jumpers.

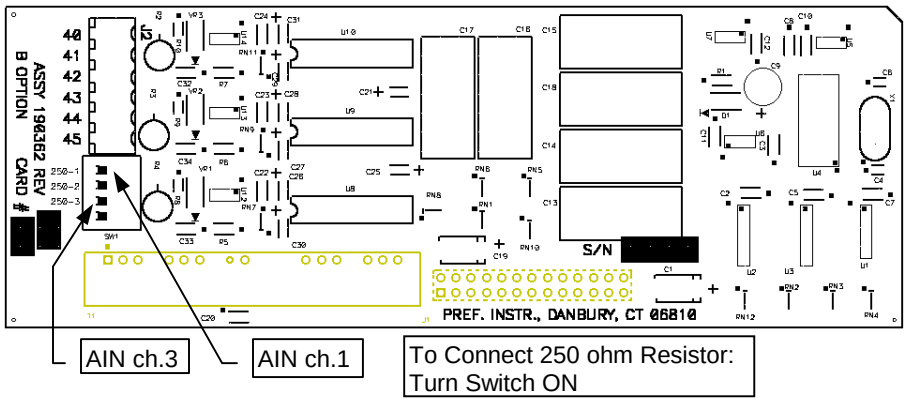
The "G" Option Board is used primarily to drive electric actuators with position feedback potentiometers. The "G" Option Board does not have internal 250 ohm resistors for the two Analog input channels on this board. Externally mounted 250 ohm resistors are required if these Analog Inputs are connected to 4-20 mA signals. Precision 250.0 ohm resistors are available separately as part number 25250-0B25-3/4.



"A" Option Board 250 ohm Switches
4-20 mA / 0-5Vdc Analog Inputs, 5 Channels

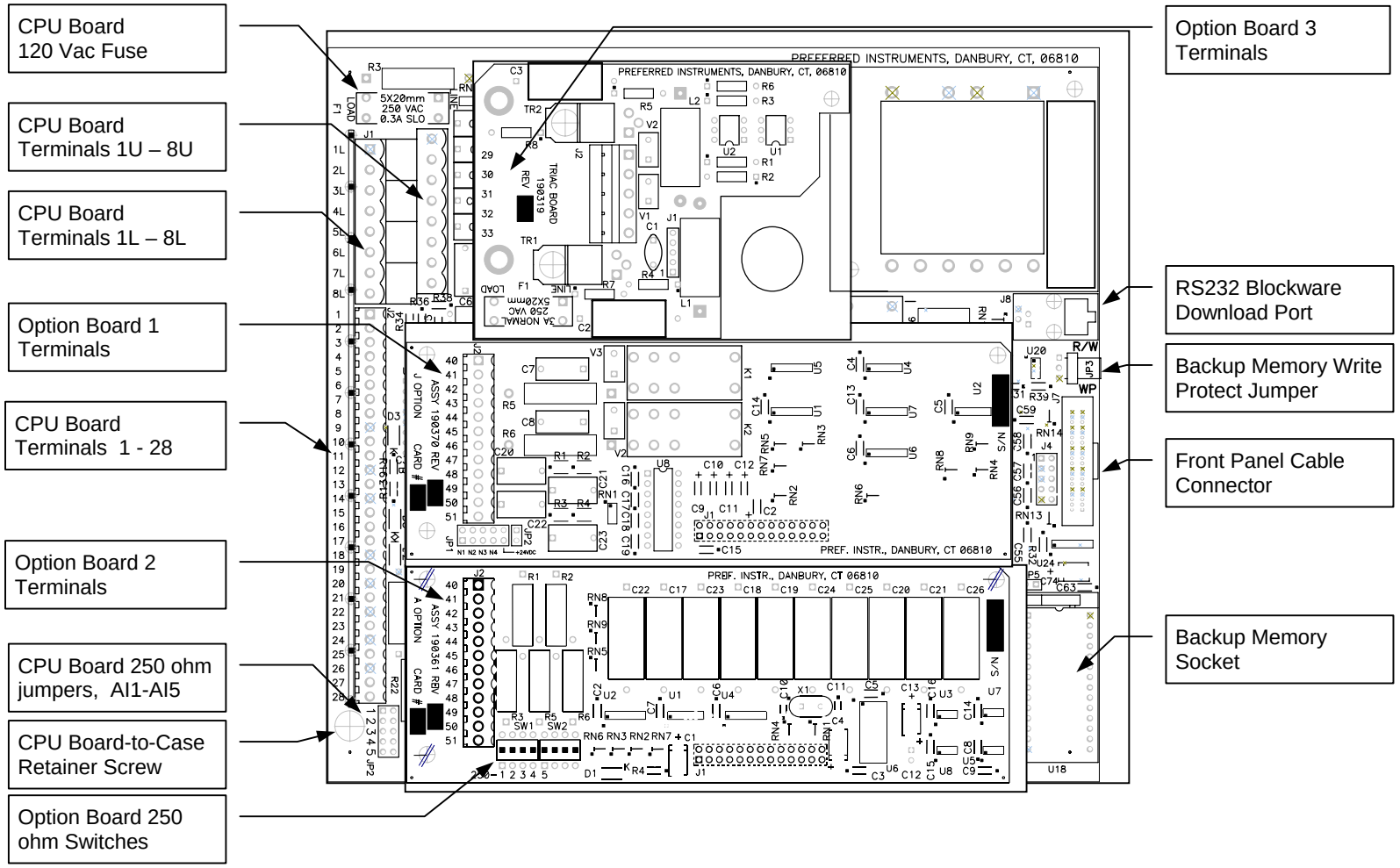


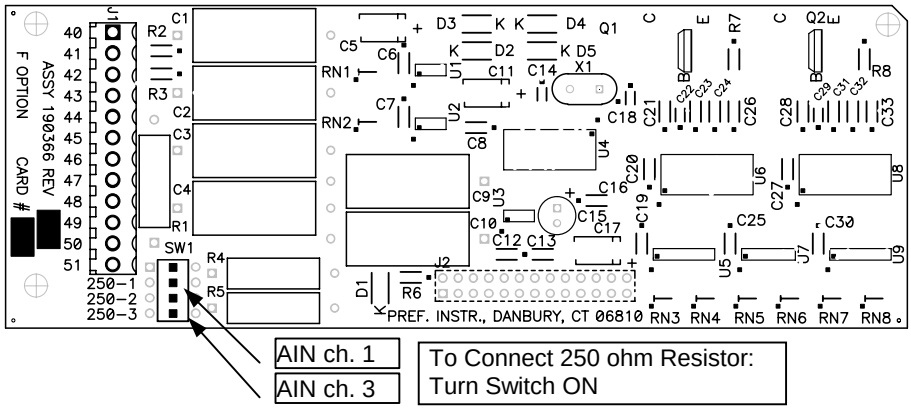
<u>Rev. 0:</u> "B" Option Board, 250 ohm Switches
4-20 mA / 0-5Vdc Isolated Analog Inputs, 3 Channels
(Isolated Ch. to Ch. and from CPU Signal Common)



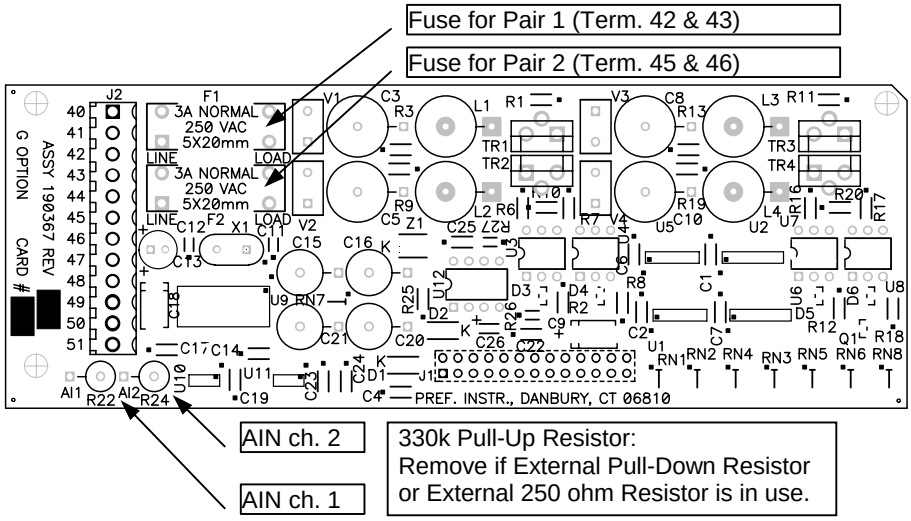
<u>Rev. A:</u> "B" Option Board, 250 ohm Switches
4-20 mA / 0-5Vdc Isolated Analog Inputs, 3 Channels
(Isolated Ch. to Ch. and from CPU Signal Common)

CPU Board Layout
Shown with 3 Option Boards Installed

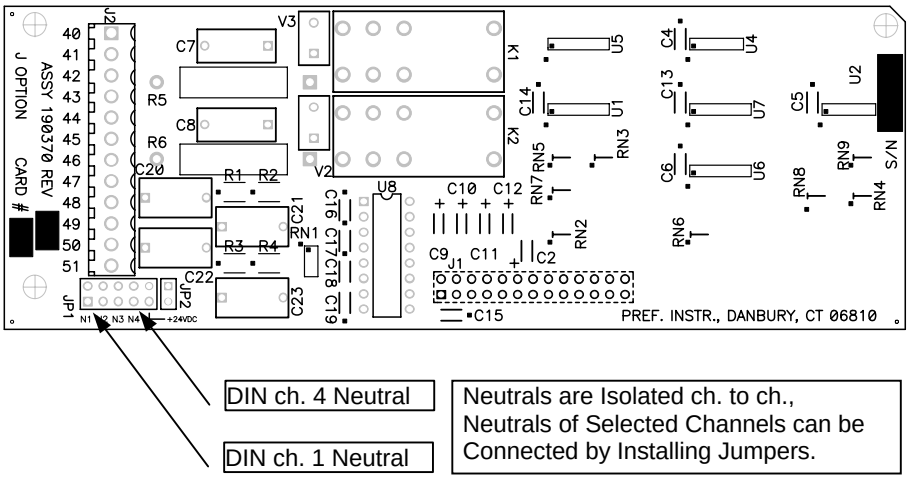




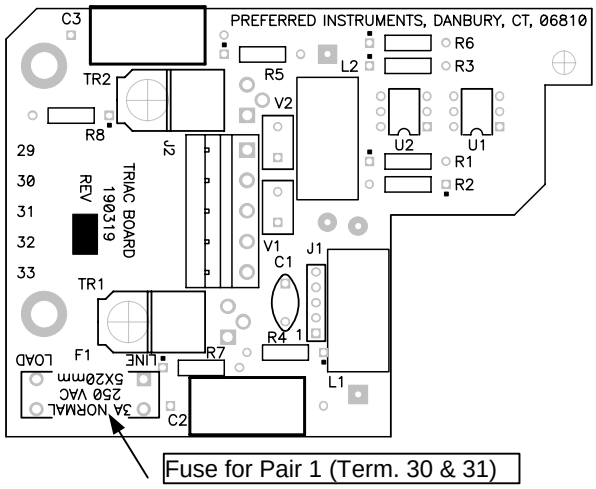
"F" Option Board 250 ohm Switches
Combination: 4-20 mA / 0-5Vdc Analog Inputs, 3 Channels
4-20 mA Analog Outputs, 2 Channels



"G" Option Board Fuses and Pull-ups
Combination: 0-5Vdc Analog Input, 2 Channels
Triac Output (AC Solid State Switch), 2 Pairs (4 Triacs)

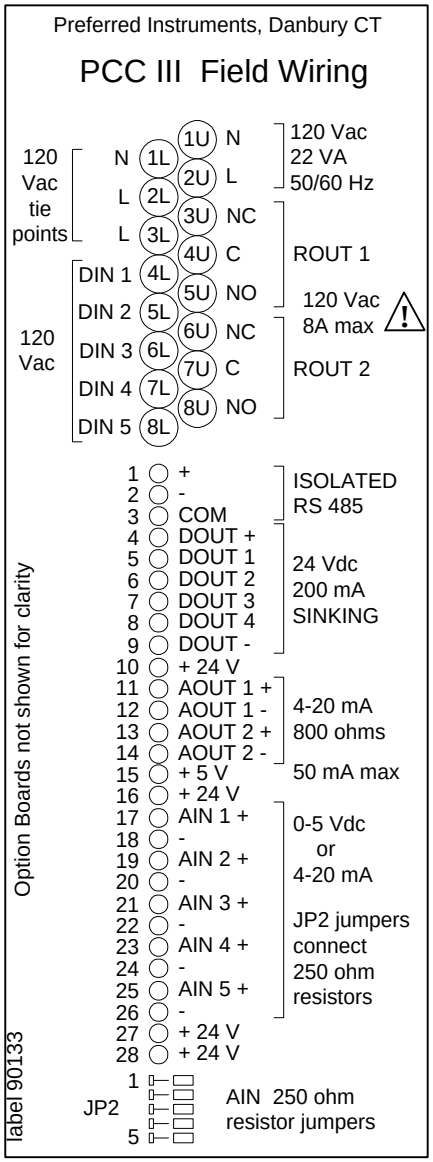

J OPTION
CARD #
ASSY 190370 REV
PREF. INSTR., DANBURY, CT 06810
DIN ch. 4 Neutral
DIN ch. 1 Neutral
Neutrals are Isolated ch. to ch.,
Neutrals of Selected Channels can be
Connected by Installing Jumpers.

"J" Option Board Isolated Neutral Jumpers
Combination: 120 Vac Isolated Discrete Inputs, 4 Channels
Relay Outputs, 8A, ½ HP, 2 Channels



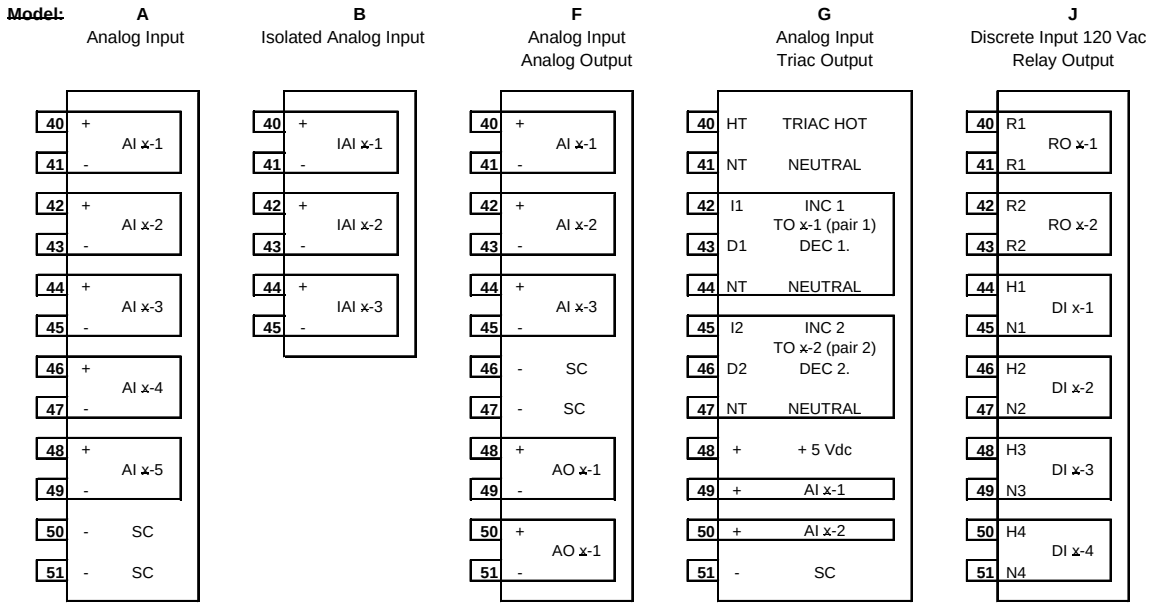
"S" Option Board 120 Vac Fuse
Triac Output (AC Solid State Switch), 1 Pairs (2 Triacs)

CPU Board Field Wiring Terminals



Option Board Field Wiring Terminals

PCC III Option Board
Field Wiring Terminal Numbers
(for Option Board Slots 1 or 2)



Notes:

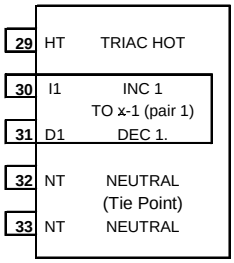
Any Combination of the above Option Cards can be used in Slots 1 or 2

"x" indicates the PC Board Number in the above channel descriptors
0 = CPU board, 1 = Option Slot 1, 2 = Option Slot 2

All of the above Option Cards use the same Terminal Numbers

When wiring schematics are created, label Terminals as "x - term. no."
"x" is the option card slot number. Examples:
1-46 means Option Card 1, terminal number 46
2-46 means Option Card 2, terminal number 46

PCC III "S" Option Board
Field Wiring Terminal Numbers
(Option Board Slot 3 Only)

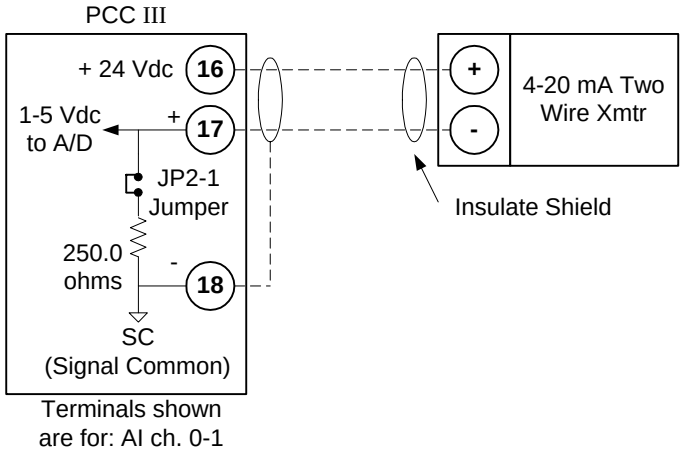


Two Wire 4-20 mA Input, Internal 24 Vdc

Typical for: CPU, “A”, and “F” boards.

This example shows Analog Input 1 on the CPU Board. Install JP 2-1 to connect the internal 250.0 ohm resistor.

The shield connects to the PCC-III Signal Common “-“.



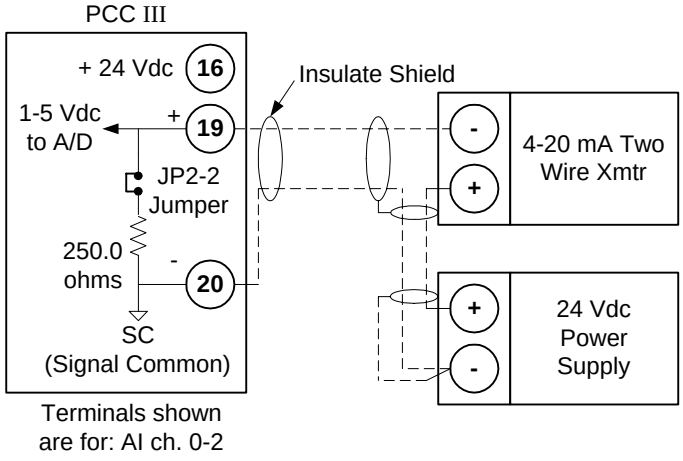
Two Wire 4-20 mA Input, External 24 Vdc

Typical for: CPU, “A”, and “F” boards.

This example shows Analog Input 2 on the CPU Board. Install JP 2-2 to connect the internal 250.0 ohm resistor.

The External Power Supply “-“ and the PCC III Signal Common “-“ must be connected.

The shield connects to the External Power Supply “-“.



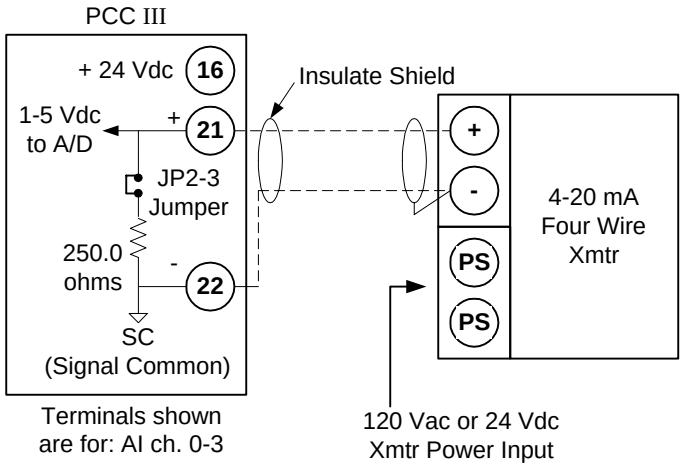
Four Wire 4-20 mA Input

Typical for: CPU, “A”, and “F” boards.

This example shows Analog Input 3 on the CPU Board. Install JP 2-3 to connect the internal 250.0 ohm resistor.

The Transmitter “-“ and the PCC III Signal Common “-“ must be connected.

The shield connects to the Transmitter “-“.



Isolated 4-20 mA Input

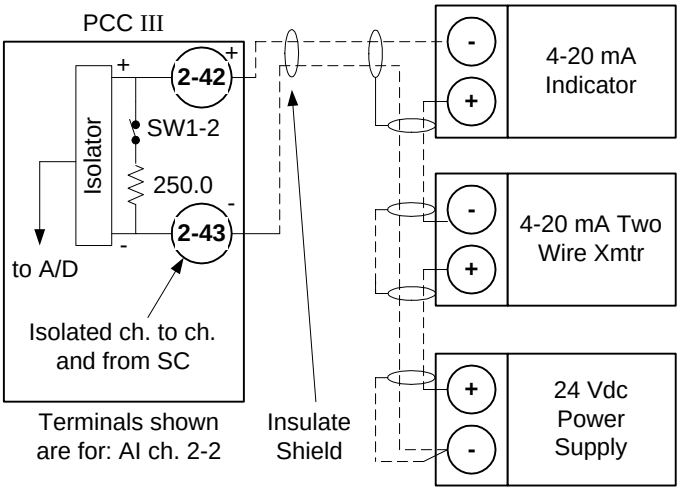
"B" Option Board Only.

This example shows Analog Input 2 on a "B" Option Board that is plugged into Slot 2. Turn ON switch 1-2 to connect the internal 250.0 ohm resistor.

The "-" of each channel is isolated from all other channels and from the CPU Signal Common "-".

The External Power Supply "-" and the "B Board "-" for this channel must be connected.

The shield connects to the External Power Supply "-".



1-5 Vdc Input

Typical for: CPU, "A", and "F" boards.

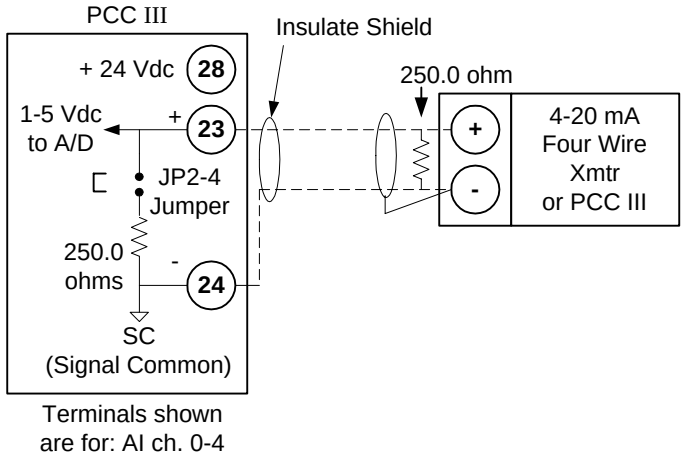
This example shows Analog Input 4 on the CPU Board. Remove JP 2-4 to disconnect the internal 250.0 ohm resistor.

The 5 Mohms input impedance of each channel allows over 15 PCC-IIIs to be connected to the same 1-5 V signal.

See "Pull-Up/Down Resistors" in this Section

The External Power Supply "-" and the PCC III Signal Common "-" must be connected.

The shield connects to the External Power Supply "-".



0-10 Vdc Input

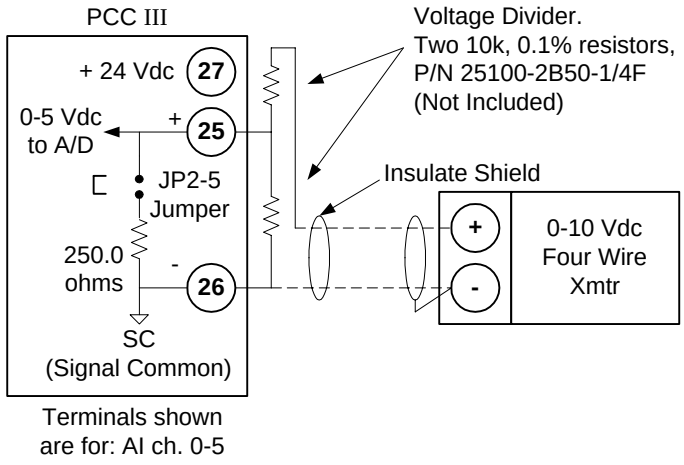
Typical for: CPU, "A", and "F" boards.

This example shows Analog Input 5 on the CPU Board. Remove JP 2-5 to disconnect the internal 250.0 ohm resistor.

The two external precision resistors reduce the signal by exactly 50%. Set the AIN Block for a 0-5V range, instead of the default 1-5V range.

The External Power Supply "-" and the PCC III Signal Common "-" must be connected.

The shield connects to the External Power Supply "-".



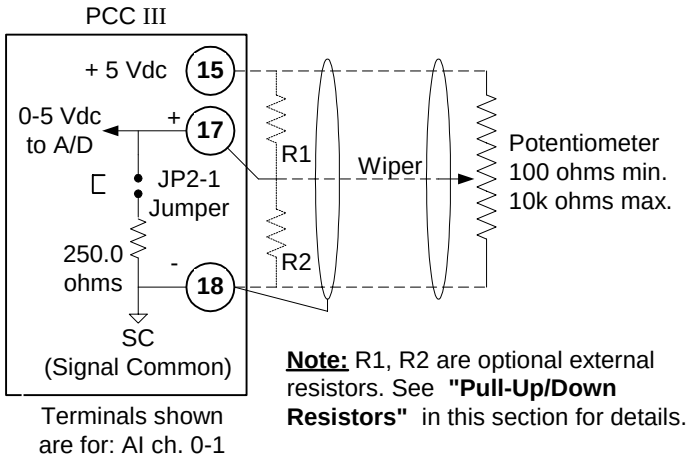
Potentiometer Input

Typical for: CPU, "A", and "F" boards.

This example shows Analog Input 1 on the CPU Board. Remove JP 2-4 to disconnect the internal 250.0 ohm resistor.

The +5 Vdc power supply (term. 15) is rated at 50 mA.

The shield connects to the Signal Common "-".



Terminals shown are for: AI ch. 0-1

Note: R1, R2 are optional external resistors. See **"Pull-Up/Down Resistors"** in this section for details.

Note: For Actuator Feedback Pots
See "Pull-Up/Down Resistors" in Section 2, and F83 TOUT in Section 6 for Fault Mode wiring considerations

Potentiometer Input, "G" Board

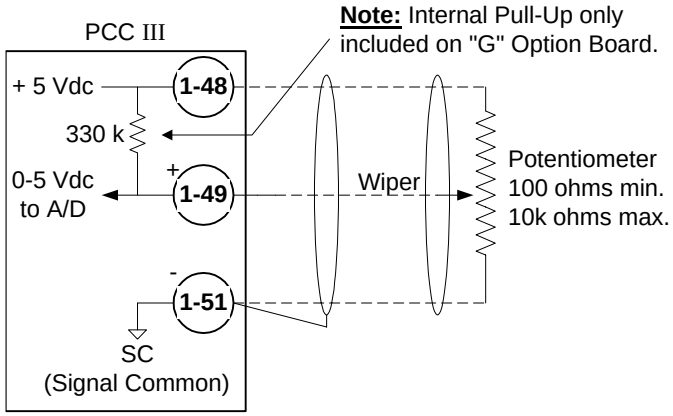
"G" Option Board Only.

This example shows Analog Input 1 on a "G" Option Board that is plugged into Slot 1. There are no 250.0 ohm resistors on the "G" board.

The +5 Vdc power supply (term. 1-48) is rated at 50 mA, total. If two pots are connected to the +5 Vdc, then the smallest value is 200 ohms (each).

The "G" board has a built-in pull-up resistor. It must be removed if an external 250.0 ohm resistor is required.

The shield connects to the Signal Common "-".



Terminals shown are for: AI ch. 1-1

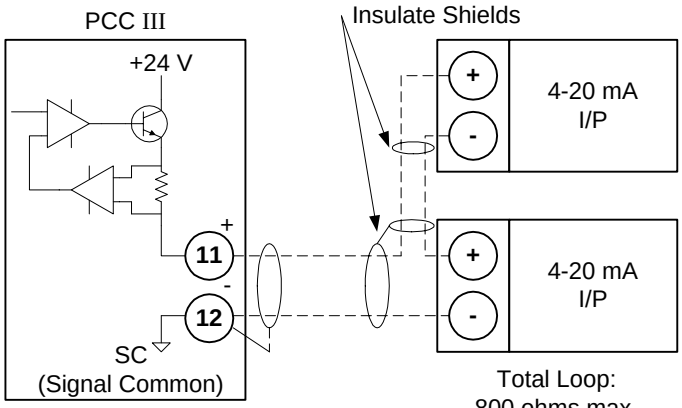
4-20 mA Output

Typical for: CPU, and "F" boards.

This example shows Analog Output 1 on the CPU Board.

The maximum 4-20 mA total loop resistance external to the PCC III is 800 ohms.

The shield connects to the Signal Common "-".



Total Loop:
800 ohms max.

Terminals shown are for: AO ch. 0-1

120 Vac Discrete Inputs, CPU Board

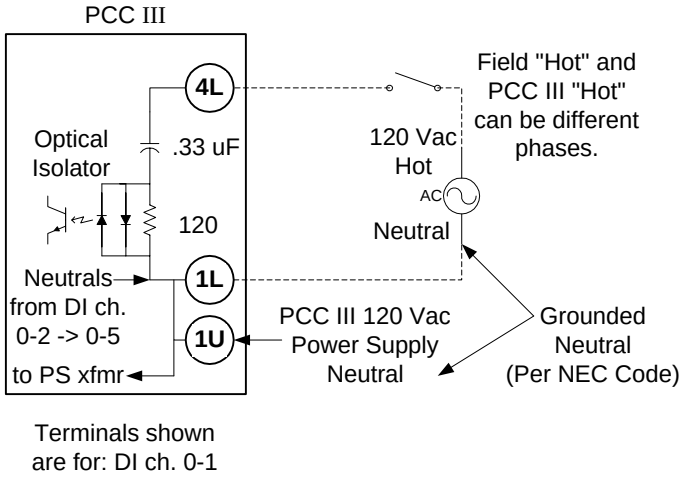
CPU Board Only.

This example shows Discrete Input 1 on the CPU Board.

The Neutral for the 5 Discrete Input channels on the CPU board is connected internally to the PCC III 120 Vac incoming power supply Neutral.

Provided that all Discrete Input power source Neutrals are Grounded (as required by NEC), then the Discrete Inputs and PCC III "Hot" can be from different phases.

Specifications:
> 90 Vac = ON
< 3 mA = OFF
Input Impedance = 8 k (+/- 20%)
Typical Input Current = 15 mA



Terminals shown are for: DI ch. 0-1

120 Vac Discrete Inputs, "J" Board Isolated Neutrals

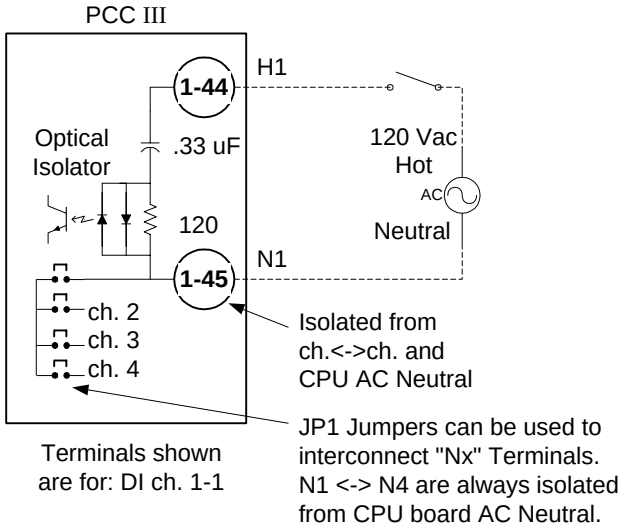
"J" Board Only.

This example shows Discrete Input 1 on a "J" Option Board that is plugged into Slot 1.

Each Discrete Input has a separate isolated Neutral which is isolated from all other channels and from the CPU Neutral.

If Isolation is not desired, jumpers on the JP1 jumper block interconnect the channel Neutrals. Each jumper connects an individual channel Neutral to an isolated inter-channel tie bus. Therefore two jumpers would have to be installed to connect the Neutrals of two different channels.

The CPU AC Neutral (terminal 1U) does not connect to the "J" board. An external wire must be run if the these isolated Neutrals need to be connected.



Terminals shown are for: DI ch. 1-1

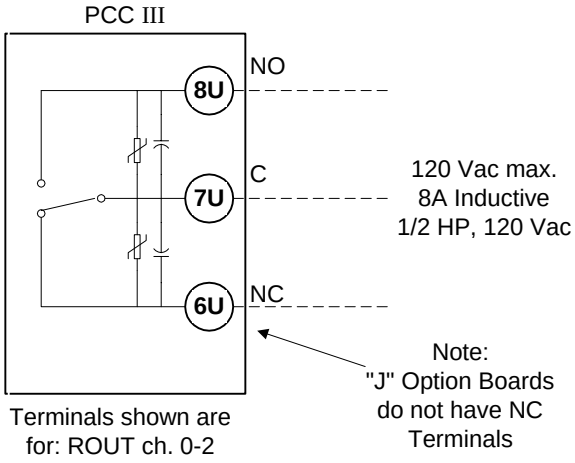
Relay Output

Typical for: CPU, and "J" boards.

This example shows Relay Output 1 on the CPU Board.

The Relay contacts are protected from damage due to inductive loads by a capacitor and a 150 V Varistor. To prevent damaging the Varistor, do not apply voltages greater than 145 Vac across the Relay contacts.

When the Relay Contacts are Open, less than 1.8 mA of leakage current is applied to the load through the snubber cap and Varistor.



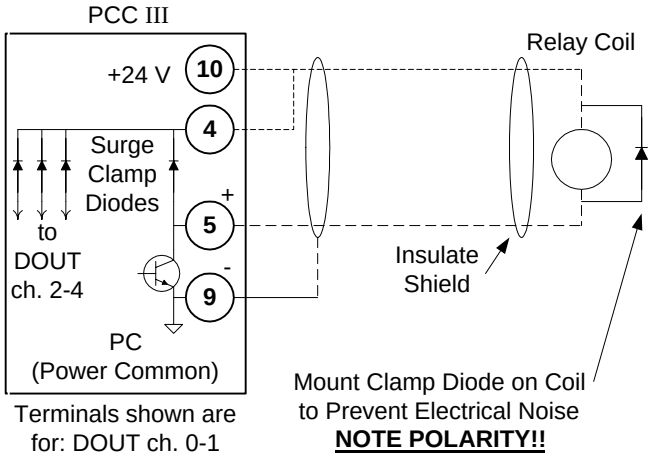
Discrete Output, Sinking, Internal 24 Vdc

CPU Board Only.

This example shows Discrete Output 1 on the CPU Board.

DOUT channels are Open Collector Transistors (ie "Sinking") with internal clamping diodes. When active, the DOUT conducts DC current to Power Common.

Coil loads (relays, solenoids, …) require an additional field mounted clamp diode on the actual coil to prevent noise induction in adjacent field wiring.
NOTE: Incorrect clamp diode Polarity causes a direct short.



Each DOUT channel is rated 200 mA max. load. See "24 Vdc Power Supply" on page 2-5 to calculate the mA current available from the 24 Vdc Power Supply.

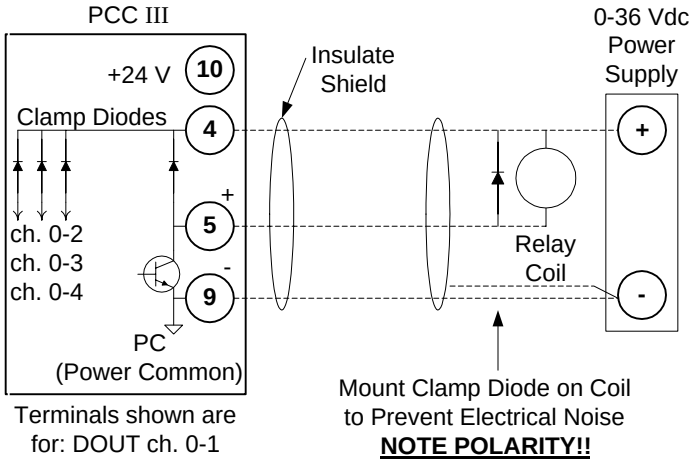
The shield connects to the Power Common "-".

Discrete Output, Sinking, External 24 Vdc

CPU Board Only.

The same comments noted above apply. This example shows an External Power supply being used to power the load.

The shield connects to the External Power Supply "-".



Triac Output,
Reversible Actuator

Typical for: “G” and “S” boards.

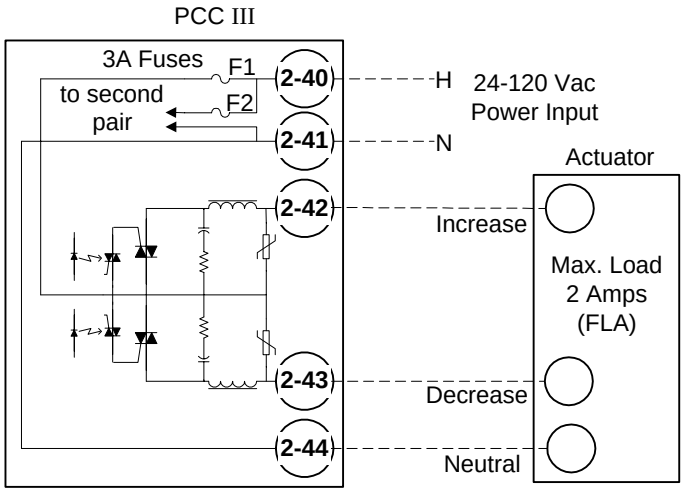
This example shows Pair 1 of a Triac Output on a “G” Option Board in Slot 2.

The Triacs are protected by surge suppressing capacitors, inductors, and varistors (6 mA leakage, typ).

The Triac Hot and Neutral supply are isolated from the PCC III 120 Vac. Each Triac pair has a separate fuse.

Motors rated 24 – 120 Vac, and 0-2 Amps are acceptable.

The “G” Board also includes two Analog Input channels. If a Position Feedback signal is required by the control strategy, See the potentiometer and 4-20 mA input examples above.



Terminals shown are for: TOUT ch. 2-1

Triac Output,
Other AC Loads

Typical for: “G” and “S” boards.

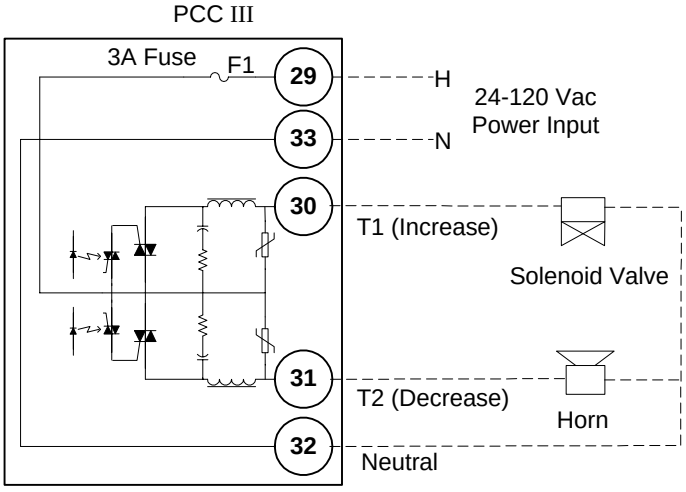
This example shows Pair 1 of a Triac Output on a “S” Option Board in Slot 3.

The TOUT Blockware allows each Triac to be controlled as a separate Solid State AC Switch.

The Triacs are protected by surge suppressing capacitors, inductors, and varistors (6 mA leakage, typ).

The Triac Hot and Neutral supply are isolated from the PCC III 120 Vac. Each Triac pair has a separate fuse.

Loads rated 24 – 120 Vac, and 0-2 Amps are acceptable.



Terminals shown are for: TOUT ch. 3-1

DC Commons and AC Neutrals Isolation

The drawing on page 2-19 shows the relationships between the various “Grounds” and “Commons” within the PCC III.

A thorough understanding of these relationships will prevent unintended “Ground Loops” in the DC and AC field wiring. “Ground Loops” is a general term to describe unintended current flows via AC Ground or DC Common circuits, which generally are NOT drawn on a schematic as a distinct field wiring connection.

DC Ground Loops can cause lower than expected 4-20 mA values due to a portion of the current bypassing the intended circuit path and traveling through some unintended parallel path. AC “Ground Loops” can cause Ground Fault Interrupter Circuit Breakers to trip if current returns via a “Neutral” that is not protected by the GFCI breaker.

Green Wire Ground: The incoming AC power Ground (the “Green” wire) is only connected to Case Ground (ie, the metal enclosure). Case Ground is isolated from all Neutrals and all DC Commons. Case Ground should always be connected to the appropriate power supply Ground, per NEC.

Line: The CPU AC Power “Line” Input (Terminal 2U) is internally connected to CPU terminals 2L and 3L. CPU Terminal 2U is NOT internally connected to any of the option boards. If a connection is desired, external wiring is required.

Hot: The “Hot” Power Inputs to the “G” and “S” Triac Output Option Boards are isolated from the CPU “Line” Input. Each Option Board “Hot” is Isolated from the “Hot” of the other Option Boards. If a connection is desired, external wiring is required. The “Hot” Input for a particular Triac Option Board is a common input that feeds all Triacs on that board.

Neutral: The CPU AC Power “Neutral” Input (Terminal 1U) is internally connected to CPU terminal 1L. CPU Terminal 1U is NOT internally connected to any of the option boards. If a connection is desired, run a field wire from the CPU board to the Option Board.

CPU Terminal 1U is the return path (or Neutral) for all current that enters any of the CPU 120 Vac Discrete Input channels (Terminals 4L – 8L). The “Hots” and “Neutral’” of all “J” Option Board 120 Vac Discrete Input channels are isolated from the CPU Board “Line” and “Neutral”. Each “J” Board Input channel is isolated from each other “J” board channel. The “J” Board is provided with jumpers to allow connecting the Neutrals of the channels together if desired.

DC Common: The DC commons (“-“) are isolated from case ground. All Signal Commons on the CPU board are interconnected, and are also connected to the Signal Commons on the “A”, “F”, and “G” Option Boards. Specifically, the following terminals are all internally connected to each other:

CPU:	9, 12, 14, 18, 20, 22, 24, 26
“A”:	x-41, x-43, x-45, x-47, x-49, x-51
“F”:	x-41, x-43, x-45, x-46, x-47, x-49, x-51
“G”:	x-51

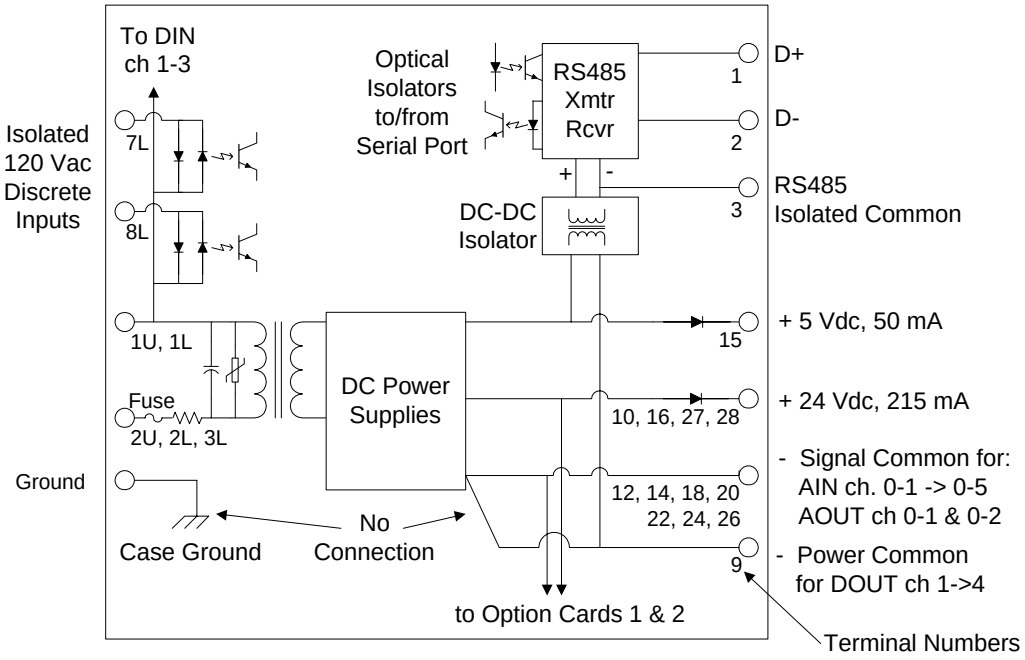
Power Common (PC): Terminal 9 on the CPU Board is reserved for “noisy” electrical loads such as external relay coils, and solenoids.

Signal Common (SC): Except for Terminal 9 (Power Common), all other DC Commons are referred to as Signal Common, and should be connected to low noise 0-5 Vdc and 4-20 mA circuits.

Isolated Signal Commons: The “-“ terminal of each channel of a “B” Option Board is isolated from all other channels on that Option Board and from the CPU Board. The “+” terminals are also isolated channel to channel and from the CPU.

Isolated RS485: Terminal 3 (“COM”) is the isolated DC Common of the isolated power supply that powers the field wiring portion of the Isolated RS485 Communications Link. The RS485 Data “+” and “-“ (terminals 1 & 2) are also isolated from the CPU Board.

CPU Board AC to DC, and DC to DC Isolation



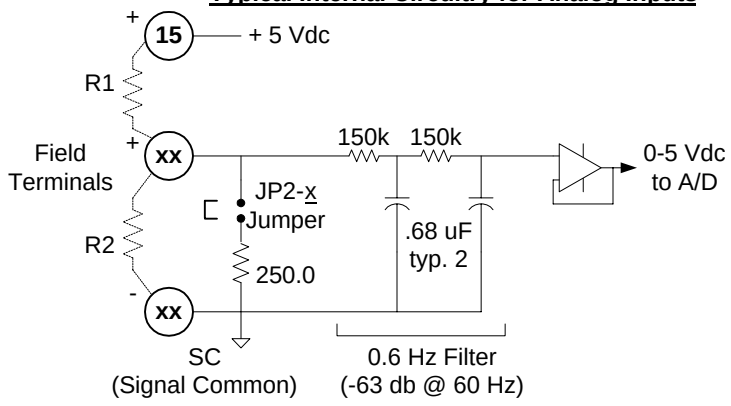
Grounds, Neutrals, and DC Commons Schematic

Pull-Up/Down Resistor for Voltage Inputs

This Sub-Section does NOT apply to 4-20 mA Inputs; that is, Inputs with the 250 ohm Resistor connected.

The 250 ohm resistor is never connected for: 1-5 V, 0-5 V, 0-10 V, and Potentiometer Inputs.

Typical Internal Circuitry for Analog Inputs



Each Analog Input has a low pass noise filter with high quality, low leakage capacitors for 60 Hz noise rejection. If the field wiring breaks, a pot wiper gets dirty, or is otherwise disconnected, the A/D Input Voltage will remain at the last value for several hours due to the capacitors in the filter.

In many applications it is desirable for the Input to fail to either 0V or 5V after the Input becomes disconnected.

A Pull-Up Resistor (R1) will force the Input to 5V after a wire break.

A Pull-Down Resistor (R2) will force the Input to 0V after a wire break.

If Required, install only one (1) Resistor, either R1 or R2. Do NOT install BOTH resistors.

The value of R1 or R2 depends on the impedance of the field device, the desired response time, and the acceptable level of error introduced by the resistor. Each application should be analyzed separately.

Example: An Input for a 1k Position Feedback Pot on an electric actuator with an "R1" Pull-Up Resistor equal to 330k. This combination adds less than 0.05% error, and has a 3 sec. response time. If the pot is wired such that approx. +5 V is 100% Open, then TOUT will drive the actuator fully closed if the feedback pot wiper circuit becomes disconnected. If the desired effect is to make the actuator fail open, then reverse the +5 and Common wires to the pot, and re-calibrate TOUT.

The CPU, "A", "B", and "F" boards do not include pull-up or pull-down resistors. If desired, the user must mount them externally.

The "G" option board includes an integral 330k Pull-Up Resistor on each Input channel.

RS485 Communications Wiring

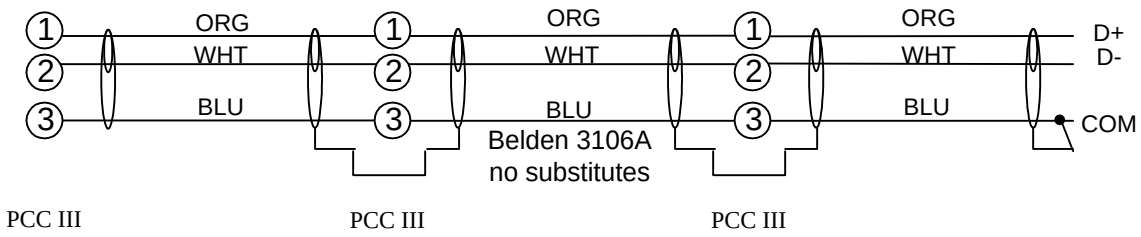
RS-485 communications wiring (terminals 1-3) is optically isolated and is not electrically connected to any other circuits within the PCC III. This means that an accidental short to the RS485 cable will not affect the operation of the other controllers (up to 31 units) connected to the cable.

RS-485 cabling may be up to 4000 feet in length. Longer distances can be accommodated by using RS-485 repeaters. RS-485 Network cabling should always be arranged in a "bus". Do not wire cabling in a "star" or with "stub" connections. See Drawings below for examples of "bus" and "stub" wiring layouts.

Belden P/N 3106A (Preferred part number 16284) is the recommended shielded cable for all PCC III RS-485 communications data highways. Belden 3106A is specifically designed for RS485 applications, and is 3 wire shielded cable arranged as: 1 twisted pair with a foil shield, plus a separate single insulated conductor that is not twisted into the main pair. The 3 wires are surrounded by a second braided shield and an overall PVC insulation. Belden 3106A has a characteristic impedance of 120 ohms, has 22 Ga. conductors, and is rated 300V @ 60C.

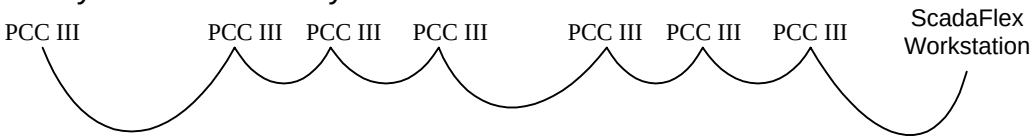
Shielding and RS-485 Commons: The shield should be connected to the RS-485 common terminal at the master station. At each PCC, PLC, RS-485/232 converter and any other devices on the network, the shields should NOT be connected to each controller's RS-485 common. The shields of the network cables should be wired together so as to continue the shield to the next controller. The single wire (ie, not part of the twisted pair) in the cable should be connected to all the Communications DC Commons on the RS-485 network. Cut off the foil and braided shields, insulate the bare shield wire and any exposed shield and connect as shown below.

RS232/RS485 Converters: Typical DCS and SCADA workstations have RS232 communications ports, and require an external RS232/RS485 converter. RS232/RS485 converters are available from: Telebyte Technology (516-423-3232) Model 8324. The RS485 Cable must have exactly one set of Pull-Up/Pull-Down resistors installed to insure that the cable is biased to greater than 0.2 Vdc differential in the "Idle" state (ie, no nodes are transmitting). The Model 8324 has internal Pull-Up/Pull-Down resistors that are activated by setting DIP switches.

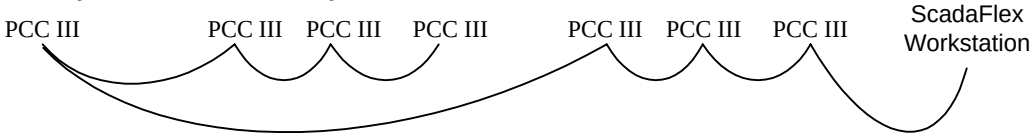


4000 ft. cable length max.
(Use Repeaters if greater than 4000 ft)

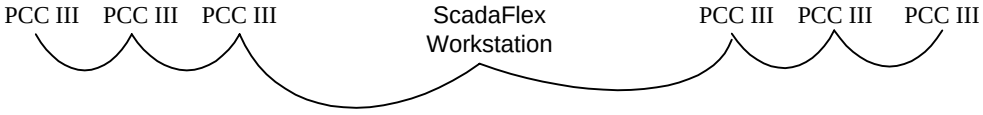
Daisy Chained Bus Layout: OK



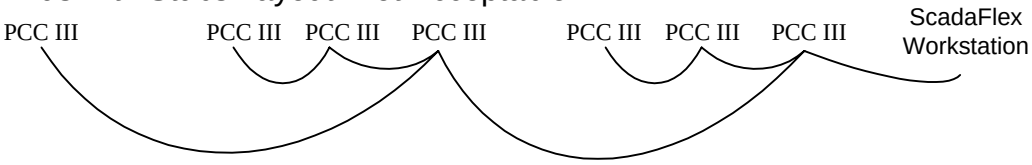
Daisy Chained Bus Layout: OK



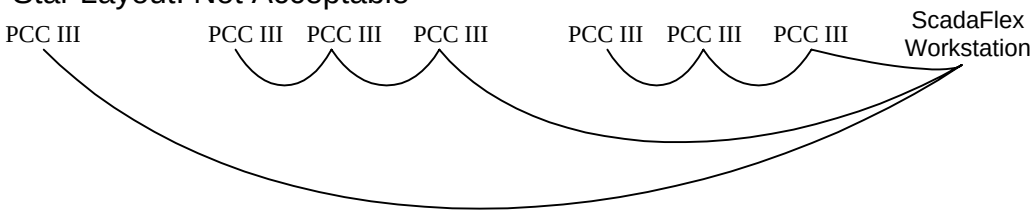
Daisy Chained Bus Layout: OK



Bus with Stubs Layout: Not Acceptable



Star Layout: Not Acceptable

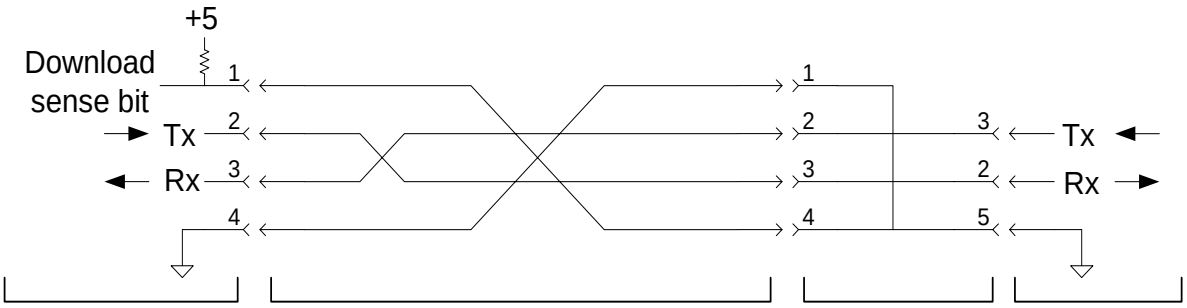


RS232 Blockware Download Cable

The PCC-III is capable of uploading and downloading Blockware Configurations and other diagnostic information via the RS-232 port on the CPU board. The signals are standard RS232 levels and can be directly connected to a standard Personal Computer Serial Port. The RS232 Port DC Common pin is connected to the PCC III Power and Signal Commons.

The connector on the CPU board is a standard 4 pin telephone handset modular jack. The wiring to connect a PCC III to a Personal Computer is shown below.

A pre-fabricated Download Cable with 4 pin modular to 9 pin DB-9 RS232 connector adapter is available as Preferred part number 190355. Assembly 190355 is also included with each PC3_Edit and PC3_Draw software package.

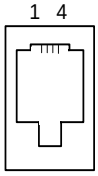


PCC III RS232 Download Connector

Standard Telephone Handset coiled cord with modular connectors

PCC III Download Adapter (p/n 190355)

Personal Computer 9 pin male serial port connector



Front View
Download Connector
Pin-out

Field Installation of Option Boards

WARNING

The PCC-III is commonly used to control potentially dangerous Combustion and Chemical Processes. VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) BEFORE REMOVING POWER FROM THE PCC-III CONTROLLER. FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

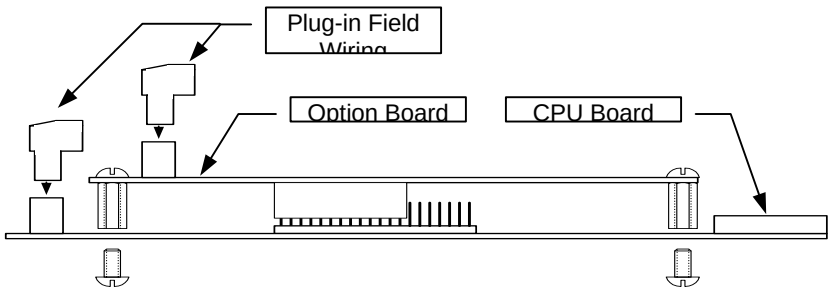
WARNING

It is very common to have multiple sources of power among the wires connected to a PCC-III. VERIFY THAT ALL SOURCES OF POWER HAVE BEEN DISCONNECTED BEFORE WORKING ON WIRING. FAILURE TO DO SO CAN RESULT IN INJURY OR DEATH.

The quantity of PCC III Input and Output channels can be expanded by adding up to three plug-in Option Boards.

These Option Boards can be field installed by competent Instrument Technicians. Refer to the procedure below, the Drawing below, and the CPU Board Layout drawing on page 2-7.

If the PCC-III is controlling a process, **it must be safely taken out of the control loop** before attempting to install any option cards.
Remove all power to the instrument. **Multiple Power Sources may be present**.
Remove the Front Panel From the PCC III: Remove the screw on the top of the Front Panel. Grasp the top corners of the Front Panel and move it forward, away from the case, about ½". Move the Front Panel Upwards and away from the case about ½". The Front Panel should now be free. Depress the two retainer clips on each side of the ribbon cable connector on the CPU Board, and remove the Ribbon Cable Connector.
Remove the rear cover from the PCC III.
Note where each field wiring Terminal Strip Connector is plugged-in.
Unplug the field wiring Terminal Strip Connectors at the rear of the circuit boards.
Unscrew the "Board-to-Case" Retainer Screw (see CPU Layout, pg. 2-7). It is located in the lower rear area of the CPU Board, next to the JP2 250 ohm jumper header .
Prepare a static free work area and protect all circuit boards from a static discharge.
Slide the main PCB out of the PCC III and place on a static protected mat.
Install the option cards as shown below. Note that the Connector for Option Slot 2 will have pins that purposely do not plug into the Option Board, plug-in as shown. Option Slots 1 and 3 do not have any "extra" pins.
Reassemble the instrument in reverse order.
Calibration may be required, see Section 4, "CALIBRATE Menu".
Wire the new Option Board(s).
Re-assemble in the reverse order.



Installation of Option Boards onto CPU Board
(Side View)

Installing Front Panel Legends

Power –down the PCC-III Controller.

WARNING: un-plugging or plugging in the front panel ribbon cable with power on can damage the controller or cause it to re-boot and possibly upset the controller process in a Dangerous manner.

Remove the front door of the PCC-II, and un-plug the ribbon cable from the door to the CPU.
Lay the door face down on a table to view the back of the front door.
Un-plug the clear plastic ribbon cable from the keypad to the display board.
Remove the three screws that secure the display board, and remove the display board.
The Legend insert slides into the keyboard pocket that is located just to the left of the short red bargraph window.
Re-assemble the Front door, and plug-in all cables.
Apply Power to the PCC-III.

Note: Legends are typically made by creating a MS Word or MS Excel document, and then printing the legend on an 8 ½ x 11 piece clear plastic. The legend is then cut down to the 2.1" H x 1.75" W pocket size. Contact Preferred Instruments Service department for a free MS Excel file that is a pre-formatted template for PCC-III Legend Inserts.

Section 3 Operation

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Operator Controls and Front Panel Usage

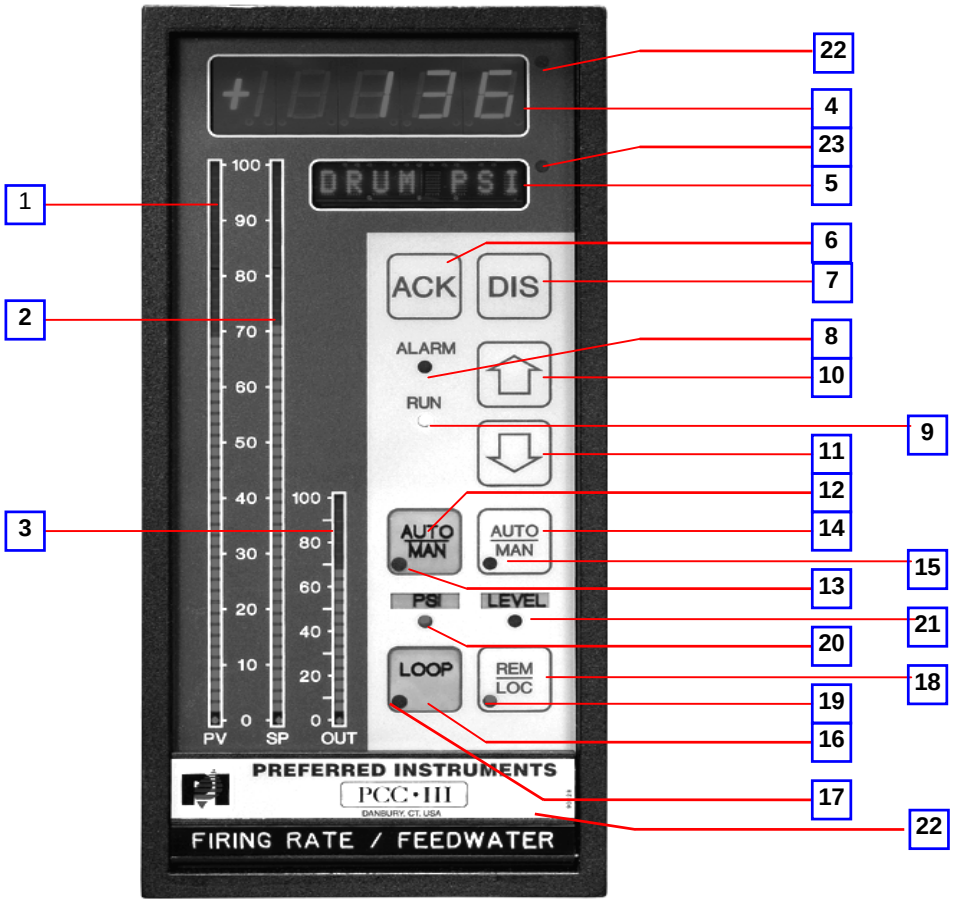

Figure 1

General

This section will explain the Front Panel displays and the operation of the Front Panel pushbuttons. This section is intended as an aid to the every day user of the PCC III controller.

The PCC III is a general purpose, software configurable, microprocessor based controller. Typical applications:

High school heating plant firing rate controller, with time of day clock, start time logic and outside air temperature reset
Multiple burner, high pressure steam boiler fuel flow and air flow controller
Boiler furnace pressure (ie draft) controller
Electric generator steam turbine throttle valve controller
Waste water pH controller
Pump and Fan variable speed drive flow/pressure controller
Batch reactor temperature controller
Paper stock consistency controller
Chemical additive ratio blending controller
Heat treating temperature controller

The same physical PCC III controller hardware is used in every case. What differentiates one controller from another is the application-specific Blockware (ie, control strategy software) in the memory of the PCC III.

By design the PCC III is exceedingly flexible, and very adaptable. For convenience, this section will use specific examples to explain how to operate the PCC III. However, the reader should remember that **each PCC III will be programmed differently to suit the needs of a particular application. For this reason, one must consult the documentation for the Blockware loaded in the memory of your specific PCC, and become familiar with your particular installation before attempting to operate the PCC III controller.**

In particular, the operation of the 4 pushbuttons and 6 lights (items 12 – 21) shown in Figure 1 changes depending on the Blockware (ie, Control Logic) that has been loaded into the memory of the PCC III. Throughout this Section, the words: "Typically", "Optionally", "Configurable", and "User defined" will be used to indicate that the operation of a pushbutton or display may in fact vary from that described in the examples given in this section.

Front Panel Displays and Pushbuttons

RUN Light

Item 9 in fig.1: The green **RUN** light indicates the health of the hardware, and indicates if the Blockware is being over-ridden (ie, FORCED or S/M), or has errors (S/M).

The **RUN** light should be ON continuously.

If the RUN light is Blinking or it is OFF, the PCC III Blockware is not operating properly. A Technician should be called immediately to determine the cause of the problem. It is normal for a Technician to purposely put the PCC III into either S/M or FORCE mode during various maintenance procedures. However, the PCC III should not be in S/M or FORCE mode during normal operation. See Section 4 for details on S/M and FORCE modes.

The RUN light indicates Normal, Forced, or S/M Mode

Green RUN Light ON / OFF Cycle	Operating Mode
ON Continuous OFF	Normal
ON 95% OFF Blinks OFF once every second	Forced Block(s) (see Section 4)
ON Blinks ON twice every second OFF 85%	Service Manual
ON OFF Continuous	Not Operating

Note: S/M Mode RUN light indication takes priority over FORCED Mode indication when both S/M and FORCED Modes are active.

PV Bargraph

Item 1 in fig.1: Typically, bargraph provides a graphical display of the **P**rocess **V**ariable (PV) over a range of from 0-100%. "Process Variable" is control system slang for: "that specific system condition that the PCC III is trying to control".

Put another way, if the PCC III is modulating a steam valve in order to control the burner fuel oil temperature, then the oil temperature is the PV (that is, Process Variable). If the PCC III is a boiler feedwater controller, the boiler drum water level is the PV.

However, the Blockware Designer is free to use this bargraph to display any other variable. The bargraph has 50 segments (individual lights), plus one "zero" light; therefore, each segment represents 2% of the range of the signal being displayed.

SP Bargraph

Item 2 in fig.1: Typically, this bargraph provides a graphical display of the **S**etpoint (SP) over a range of from 0-100%. "Setpoint" is control system slang for: "that specific value at which the PCC III should maintain the Process Variable".

Put another way, if the PCC III is modulating a steam valve in order to control the burner fuel oil temperature, then as noted above the oil temperature is the PV (that is, Process Variable). If you want to keep the oil temperature at a constant 220 deg F, then the Setpoint would be 220 deg F.

Typically, when the two bargraphs are setup to display PV and SP simultaneously, both bargraphs will be at the same height when the PCC III is in AUTO and the controller is maintaining the desired Setpoint.

However, the Blockware Designer is free to use this bargraph to display any other variable. The bargraph has 50 segments (individual lights), plus one "zero" light; therefore, each segment represents 2% of the range of the signal being displayed.

OUT Bargraph

Item 3 in fig.1: Typically, this bargraph provides a graphical display of the **OUT**put of the PCC III over a range of from 0-100%. "Output" is control system slang for: "whatever the PCC III is changing in an effort to maintain the process at the desired setpoint".

Put another way, if the PCC III is modulating a steam valve in order to control the burner fuel oil temperature, then the 4-20 mA signal being sent to the steam valve positioner is the Output. In this case the OUT bargraph would indicate 0-100% of the steam control valve's opening demand signal.

However, the Blockware Designer is free to use this bargraph to display any other variable. The bargraph has 20 segments (individual lights), plus one "zero" light; therefore, each segment represents 5% of the range of the signal being displayed.

Numeric Display

Item 4 in fig.1: This display is used to show numbers. Typically the values shown are shown in the correct engineering units. That is, the numbers are usually not in units of from 0-100%. See **ACK** and **DIS** for more details.

Message Display

Item 5 in fig.1: This display is used to show messages that can be displayed using the characters A-Z, 0-9, and most of the recognized symbols (+, -, <, /, %, ….). The message display can show up to 8 fixed characters at a time or longer messages which simply scroll across the display. See **ACK** and **DIS** for more details.

All of the Process Display channel messages, and all of the Alarm Annunciator messages can be modified by the user in the field without any special programming hardware (see section 4).

DIS Pushbutton

Item 7 in fig.1: The PCC-III is capable of displaying up to 10 channels of Process Control information. Pressing the **DIS** pushbutton causes the next display channel to appear on the Message and Numeric displays. The display channel sequence repeats after the last channel is displayed. Repeatedly pressing the **DIS** pushbutton in order to cycle through the display channels is called "scrolling" through the display channels.

Each display "channel" consists of a Numeric display and a Message display working as a matched pair to display one "variable". Pressing **DIS** to scroll through the display channels causes both the Numeric and Message displays to change to the next display channel at the same time.

A typical display "channel" example would be boiler drum steam pressure (the "variable"). After scrolling to this display channel with the **DIS** pushbutton, the Numeric display (item 4) might show "**+ 149**" (for 149 psig) while the Message display (item 5) simultaneously showed "**DRUM PSI**".

If the displays are currently showing an Alarm Annunciator message, press **DIS** to return to the display of the Process Control display channels.

<u>The operation of the **DIS** pushbutton can not be changed by the Blockware designer.</u> In normal operation, the **DIS** pushbutton can always be used to scroll through the display channels.

There are only three reasons why depressing the **DIS** pushbutton would not cause a change in the display channel:

If the EDIT light (item 22) is ON. See Section 4 for instructions on how to exit the EDIT mode.
The Blockware loaded in the PCC III memory does not have any display channels.

If the green RUN light is OFF or blinking indicating that the controller may need to be serviced.

⇑ and ⇓ Pushbuttons

Item 10 and 11 in fig.1: These pushbuttons are used to increase or decrease the value that is currently being displayed on the Numeric display. These pushbuttons can only be used to change values that the Blockware Designer has configured to be modifiable from the Front Panel.

Typically the Setpoint, the Controller Output (when in Manual), Ratio, Bias, and other values can be changed with these pushbuttons.

The Blockware Designer can also limit the amount of adjustment that is possible. For example, if The Setpoint is normally 150 psig, the Blockware designer can internally limit the range of adjustment to 125 – 175 psig.

⇑ and ⇓ Rate of Change

When the Operator presses and holds down either the ⇑ or ⇓ pushbutton, the displayed value will initially ramp slowly. However, after every 10 counts the display ramp speed increases by a factor of ten. Therefore, the longer the ⇑ or ⇓ pushbutton is pressed, the faster the displayed value will change.

Example:
Assume the Numeric display initially shows 0.00
The Operator presses and continuously holds down the ⇑ pushbutton.
The Numeric display would change as follows:

0.00, 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09,
0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90,
1.00, 2.00, 3.00, 4.00, 5.00, 6.00, 7.00, 8.00, 9.00
…

Note: the ramping sequence does not have to start with the right hand digit equaling “0” as shown in the above example. If the initial display value had been 0.03, the ramp rate would change after 0.13, 1.03, 10.03, 100.03, …, that is after every 10 display value changes.

Whenever the ⇑ or ⇓ pushbutton is released, the ramping rate is reset to the slowest rate. **Therefore, if you don’t want the displayed value to change rapidly, release the ⇑ or ⇓ pushbutton after the displayed value has changed by 8 or 9 counts.**

AUTO / MAN Pushbutton and Light

Items 14 and 15 in fig.1: This pushbutton and light are both User defined.

However, it would be very unusual for a Blockware designer to use this pushbutton / light pair for anything besides selecting the Automatic or Manual mode for the controller’s Output.

Typically, when the light is ON, the controller is in Manual (MAN). When the light is OFF, the controller is in Automatic (AUTO). The pushbutton is typically configured as a toggle type. That is, every time the pushbutton is pressed, the status toggles to the opposite status: MAN to AUTO, AUTO to MAN, MAN to AUTO, ….

Auto-DIS (Automatic Display Channel Selection): Auto-DIS is an optional feature that most Blockware designers utilize. Auto-DIS connects the **AUTO/MAN** pushbutton to the display channel selection logic as follows:

When **AUTO / MAN** changes from MANual to AUTO, display ch. 2 (typically the PV) is automatically selected.
When **AUTO / MAN** changes from AUTO to MANual, display ch. 1 (typically the OUT) is automatically selected.

However, after Auto-DIS has changed the display channel, the Operator can still use **DIS** to select a different display channel.

Without Auto-DIS, the Operator would have to first change the **AUTO / MAN** pushbutton and then manually change the display channel with the **DIS** pushbutton.

Auto/Manual Example

This example would cover a typical Blockware control logic case. However, your Blockware may be different. Review the documentation provided with the Blockware for your specific controller to determine the purpose of each pushbutton.

Assume that the controller has the AUTO/MAN pushbutton configured to allow selection of either the automatic or manual mode … Auto-DIS is in use … there is NO Blockware that overrides MAN mode … the Output is currently in AUTO … and the Output is initially set to 4%.

To put the controller Output into Manual and then set the Output (ie, the valve, or damper, or …) to 20 % open:

Press the AUTO / MAN pushbutton.
The AUTO / MAN light will come ON, indicating that the Output is in Manual mode.
The Display channel will automatically change to the Output channel (VALVE, or DAMPER, or a similar message will be displayed on the Message display).
Press and hold the ⇑ pushbutton.
The Numeric display will start ramping up from 4%.
Momentarily release, and then press and hold the ⇑ pushbutton when the Numeric display shows 12 or 13.
This resets the ramp rate change logic, and keeps the ramp rate at the slowest ramp rate.
When the Numeric display shows 20, release the ⇑ pushbutton.
If desired, you can now press the **DIS** pushbutton to scroll through (ie, change) the display channels.
As long as the AUTO / MAN pushbutton remains in Manual (the light will be ON), the Output will remain at 20%, even though a different display channel may be displayed.
If an alarm occurs, you can press the **ACK** button to view the alarm message, and to silence the alarm horn (if supplied). The Output will remain at 20%. Press **DIS** to return to the display channels.
No matter which display channel is currently being displayed, when the AUTO / MAN button is pressed again, the Output will return to that corresponding with the Automatic control mode.

ALARM Light

Item 8 in fig.1: The Alarm Light operates as follows:

Alarm Light	Status
Blinking	One or more alarm messages have NOT been displayed. Press **ACK** to display the next alarm message.
ON	All alarm messages have been displayed. 1 or more alarm inputs are still in the alarm condition.
OFF	All alarm messages have been displayed. No alarm inputs are in the alarm condition.

The operation of the **ALARM** light can not be changed by the Blockware designer. However, alarm(s) can be disabled by Blockware. Typically, this is done to prevent nuisance alarms when a process is shutdown.

ACK Pushbutton and the Alarm Annunciator

Item 6 in fig.1: The PCC-III can monitor up to 10 different alarm conditions. This pushbutton is used to ACKnowledge new alarms, and typically to silence an optional panel-mounted or remote alarm horn or bell.

When a new alarm condition occurs, the **ALARM** light (item 8) will start blinking. Optionally, the Blockware designer can cause the PV and SP bargraphs to blink, and if supplied, activate a panel-mounted or remote alarm horn, bell, and/or light.

Pressing **ACK** will cause the Message display to show the first of up to 10 alarm messages, and it will silence any optional alarm horns or bells. If the **ALARM** light continues to blink, then there are additional alarm messages that have not been displayed. Press **ACK** again to allow the next alarm message to appear on the Message display.

The Annunciator records and plays back alarm messages in the same sequence as the alarms actually occurred. The Numeric display is used to indicate the sequence number of the alarm message currently being displayed, and the total quantity of alarm messages in the alarm memory. The Numeric display shows two numbers separated by a blank space. The left digit is the sequence number (1 is the first to occur) and the right digit is the total quantity of alarm messages in memory. Alarms that are no longer in the alarm state are deleted from the list after all message have been displayed at least once.

Example:
A feedwater controller monitors and has alarm channels for: Low Feedwater Supply Pressure, High Drum Level, Low Drum Level, and Low-Low Drum Level. Assume that a boiler modulates up to maximum rate, but the

feedwater pump capacity is inadequate, the feedwater pressure drops, the drum level drops and the boiler eventually trips due to low-low water level. After the boiler trips the feedwater pressure returns to normal pressure. The displays would respond as follows:

Condition	ALARM light	Message	Numeric	ACK pushbutton	Comment
Low feedwater supply pressure	Blink	Process Control Display	Process Control Display		Operator not present
Low Drum Level	Blink	Process Control Display	Process Control Display		
Low Low Drum Level trip	Blink	Process Control Display	Process Control Display		
Feedwater Supply Pressure returns to normal	Blink	Process Control Display	Process Control Display		
	Blink	LOW WATER PSI	1 3	Press	Operator returns
	Blink	LOW DRUM LEVEL	2 3	Press	
	Blink	LO-LO DRUM LEVEL	3 3	Press	
Low Low Level trip returns to normal	ON	LOW DRUM LEVEL	1 2	Press	
	ON	LO-LO DRUM LEVEL	2 2	Press	
Low Level returns to normal	OFF	LO-LO DRUM LEVEL	2 2		
	OFF	NO MORE ALARMS		Press	
	OFF	Process Control Display	Process Control Display		Press DIS pushbutton

When one wishes the displays to stop showing Alarm Annunciator messages, and return to showing normal Process Control display channels, press **DIS** (Item 7).

The operation of the **ACK** pushbutton can not be changed by the Blockware designer. However, alarm(s) can be disabled by Blockware. Typically, this is done to prevent nuisance alarms when a process is shutdown.

User Defined Pushbuttons

Items 12, 14, 16, and 18 in fig.1: These four pushbuttons are configured by the Blockware designer. The Purpose and Operation of each of these pushbuttons is determined by the Blockware designer. Review the documentation provided with the Blockware for your specific controller to determine the purpose of each pushbutton.

Items 12 and 16 can be labeled by the user to indicate the purpose of each pushbutton. Items 14 and 18 are permanently labeled.

User Defined Lights

Items 13, 15, 17, 19, 20 and 21 in fig.1: These six lights are configured by the Blockware designer. The Purpose and Operation of each of these lights is determined by the Blockware designer. Review the documentation provided with your specific controller's Blockware to determine the purpose of each light.

Items 13, 17, 20, and 21 can be labeled by the user to indicate the purpose of each light. Items 15 and 19 are permanently labeled.

The four lights that are located within the outline of a pushbutton are all actually controlled by Blockware that is independent of the operation of the pushbutton itself. While it is very common for these four lights to be used to indicate when the pushbutton is ON, it is not unusual for some of these lights to be used as simple indicators that are not affected by the operation of the mating pushbutton.

Multiple Loops

PCC III can control more than one “loop” at the same time. The method used to accomplish this is selected by the Blockware Designer. Review the documentation provided with your specific controller’s Blockware to determine the requirements specific to your application. Two different loop select methods are described below. Only one of the two methods will be used.

LOOP Pushbutton Loop Select Method: As shown in figure 1, one PCC III can simultaneously control Boiler Firing rate based on Drum pressure (the first “loop”) and the Feedwater Control Valve based on Drum Level and Steam Flow (the second “loop”). However, the Front Panel displays will display only one of the two loops at a time. The Operator will Select which loop is to be displayed by pressing the LOOP pushbutton.

In this example, the PSI and LEVEL lights indicate which loop (LEVEL or PSI) is currently being displayed on the bargraphs, and which loop Auto-DIS is using to select a display channel (see pg. 3-5 for Auto-DIS). Pressing the LOOP pushbutton causes the selected loop to toggle back and forth: LEVEL to PSI, PSI to LEVEL, LEVEL to PSI,…

Once a loop is selected, Auto-DIS works as described above for the currently selected loop. If PSI is the selected loop: Auto-DIS would display PSI when the PSI AUTO/MAN button is put into AUTO, and FIRING RATE when put into MAN. If LEVEL was the currently selected loop, Auto-DIS displays DRUM LEVEL in AUTO and FEEDWATER VALVE in MAN.

AUTO/MAN Pushbuttons Loop Select Method: An Alternative method for selecting the currently displayed loop is to use one of the two AUTO/MAN pushbuttons for each loop as the as the loop select Pushbutton. This method is used when there is no Loop pushbutton.

If the LEVEL loop is currently being displayed, pressing the PSI AUTO/MAN pushbutton would change the displays from the LEVEL loop to the PSI loop, but the PSI AUTO/MAN status would not change. After the PSI loop has been selected for display, pressing the PSI loop AUTO/MAN pushbutton would toggle the Auto-Manual status as expected.

One of the two lights, PSI or LEVEL (items 20 and 21) would be ON to indicate which loop is being displayed.

When the PSI loop is currently being displayed, pressing the LEVEL AUTO/MAN pushbutton would change the displays from the PSI loop to the LEVEL loop, but the LEVEL AUTO/MAN status would not change. After the LEVEL loop has been selected for display, pressing the LEVEL loop AUTO/MAN pushbutton would toggle the Auto-Manual status as expected.

Section 4: EDIT Menu Operations

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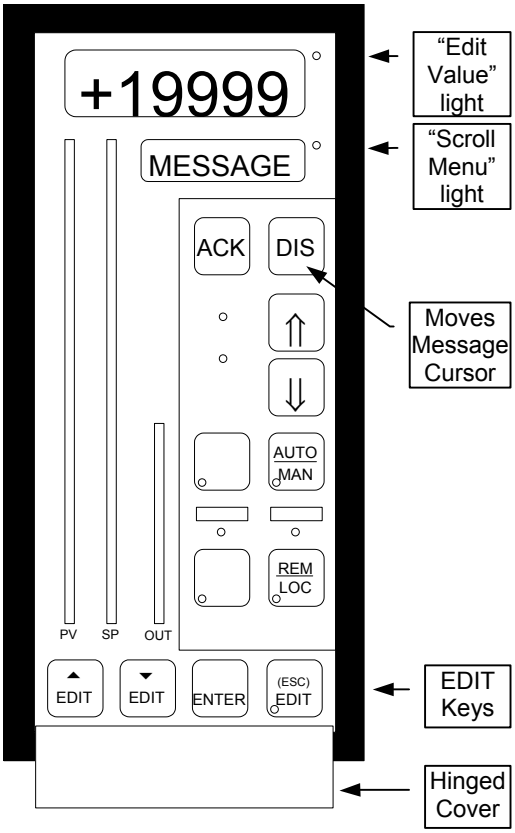
Introduction



The PCC III Blockware (ie the control strategy) is software based, and is totally field configurable. The PCC III Blockware, on-line diagnostics, and other controller configuration data can be viewed or modified using any one of the three methods that follow:

Front Panel EDIT Menus: Using the EDIT keys (see figure) and the Front Panel displays; any and all possible configurations can be accomplished without the use of a Personal Computer. Some examples of what can be accomplished from the EDIT keys:

- Assigning Function Types to Blocks
- Softwiring from Block to Block
- Blockware data entry
  - PID tuning
  - Alarm setpoint adjustment
  - Enter/Edit Alarm messages
- Blockware debugging
- Copy Primary Memory to Backup and vice versa
- Service Manual Mode Control
- On-line diagnostics
- Passwords
- Miscellaneous Setup

This Section will describe the purpose and operation of every EDIT menu item and every EDIT key.

PC3-Edit Personal Computer based software: The PCC III Blockware can be designed and entered using the PC3_Edit software on a Personal Computer and then downloaded into the PCC III via the RS232 Download Port (behind the Front Panel).

PC3_Edit is a Windows 95/98 based “point and click” style program that is arranged in a spreadsheet format with a convenient fill-in-the-blanks approach. Each Block has an unlimited length "Comments" field for documentation, and the Blockware data and comments can be printed to any Windows compatible printer. PC3_Edit can also upload Blockware from a PCC III into PC3_Edit. PC3_Edit can be used to do on-line troubleshooting because it displays the real-time outputs of every Block in the PCC III.

This manual does not cover the operation and use of PC3_Edit.

PC3-Draw Personal Computer based software: PC3_Draw includes all of the features of PC3_Edit; however, the approach is CAD based, rather than spreadsheet based. PC3_Draw includes a menu with a pre-drawn figure for each PCC III Blockware Function Type. The user simply drags the desired Functions onto the Drawing Page, and then uses Smart “Connector” lines to interconnect the Blocks. Double Clicking on any block allows the user to edit data within the Block. The resulting drawing can be printed on a plotter, and the Blockware data can also be printed in the PC3_Edit tabular format .

This manual does not cover the operation and use of PC3_Draw.

EDIT Keys

All data entry, editing, and diagnostics are accomplished with the four **EDIT** keys behind the hinged cover (see pg 4-2) in conjunction with the numeric and alphanumeric digital displays. The EDIT menus may be entered at any time, and the PCC III Blockware will continue to execute normally. However, since the displays are showing EDIT Data; none of the Front Panel Process Mode display channels can be displayed or modified (i.e. Setpoint, Controller Manual Output, etc.).

The EDIT menus can always be used to display any and all data in the PCC III memory, regardless of the password or S/M status. However, data can only be changed if the password and/or S/M mode restrictions are satisfied, see Sections 4 and 6.

The majority of the Blockware Parameters (tuning, alarm setpoints, time delays, characterizer breakpoints, …) can be changed on-line with the Blockware continuing to execute. However, changing the Function Type of a Block, changing Softwiring, and changing Input/Ouput channel assignments can have a drastic affect on the controller Ouputs; therefore, PCC III must be in Service Manual Mode in order to make these changes (pg 4-8).

EDIT Light

When the **EDIT** light is OFF: The **EDIT** Menus, and the **ENTER**, **EDIT ▲** , and **EDIT** keys are disabled. A Process mode display channel, or an Alarm Annunciator Message, and the **DIS,** ⇑, ⇓**,** and **ACK** keys will all be enabled. Press the **EDIT** key to turn ON the **EDIT** light, and to activate the **EDIT** menus.

When the **EDIT** light is ON: The **EDIT** Menus, and the **ENTER**, **EDIT ▲** , and **EDIT ▼** keys are all enabled. The Process mode display channels, Alarm Annunciator Messages, and the **DIS,** ⇑, ⇓**,** and **ACK** keys will all be disabled. However, the Blockware, the bargraphs, the other 4 pushbuttons (**AUTO/MAN, REM/LOC**, and two more User defined keys), and the 6 User defined Lights will all continue to operate normally. See **ESC** below for details on how to turn OFF the **EDIT** light, and exit the **EDIT** menus.

(ESC) / EDIT key

When the **EDIT** light is OFF: Pressing (**ESC) / EDIT** turns ON the **EDIT** light and activates the **EDIT** menus.
When the **EDIT** light is ON: The EDIT menus are active, and the (**ESC) / EDIT** key is only used as an **ESC** (Escape) key. Therefore, throughout the remainder of this Section this key will simply be called the **ESC** key.

Pressing **ESC** when a menu item is displayed, will cause the display to jump back to the previous menu. If any MAIN menu line item is being displayed, pressing **ESC** will exit the EDIT menus and activate the Process mode display channels.

If the **ESC** key is pressed while a Numeric value is being changed, the new value will not be saved, and the origianl value will continue to be used by the Blockware.

Edit Value and Scroll Menu Lights

Generally the **EDIT ▲** and **EDIT ▼** keys are used to scroll through menus on the Message display; however, when editing a numerical value, the **EDIT ▲** and **EDIT ▼** keys change the value shown on the Numeric display. When BOTH the Message and Numeric displays are showing data, ONE of the two lights (Edit Value or Scroll Menu) will blink to indicate which display the **EDIT ▲** and **EDIT ▼** keys are going to change.

EDIT ▲ and EDIT ▼ keys

The **EDIT ▲** and **EDIT ▼** keys are used to "scroll" up or down through the line items of any of the EDIT menus (see next page). The menu line item scrolling does not "wrap-around". That is, if the MAIN menu is active and PASSWORD MENU is displayed, pressing **EDIT ▲** moves up one line to ENTER S/M, pressing **EDIT ▲** again displays QUICK MENU, pressing **EDIT ▲** again will not change the display because QUICK MENU is the "top" of the menu.

The **EDIT ▲** and **EDIT ▼** keys are also used to change the value of the number shown on the Numeric display (**Edit Value** light must be blinking). These keys can also be edit messages in the PANEL Block, see pg 4-15. any EDIT men and to increase the value of displayed parameters. When used in conjunction with the various Menus and Sub-Menus, depressing **EDIT ▲** will move up the page to the previous line in the menu. When used to change parameter values during configuration (numeric display flashing), depressing **EDIT ▲** will increase the value, or in the case of message generation (alphanumeric display character flashing), **EDIT ▲** will scroll forward through the alpha, numeric and symbol strings.

EDIT ▲ and EDIT ▼ Rate of Change

When the User presses and holds down either the **EDIT ▲** or **EDIT ▼** key, the displayed value will initially ramp slowly. However, after every 10 counts the display ramp speed increases by a factor of ten. Therefore, the longer the **EDIT ▲** or **EDIT ▼** key is pressed, the faster the displayed value will change.

Example:
Assume the Numeric display initially shows 0.00
The User presses and continuously holds down the **EDIT ▲** key.
The Numeric display would change as follows:

0.00, 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09,
0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90,
1.00, 2.00, 3.00, 4.00, 5.00, 6.00, 7.00, 8.00, 9.00
…

Note: the ramping sequence does not have to start with the right hand digit equaling "0" as shown in the above example. If the initial display value had been 0.03, the ramp rate would change after 0.13, 1.03, 10.03, 100.03, …, that is after every 10 display value changes.

Whenever the **EDIT ▲** or **EDIT ▼** key is released, the ramping rate is reset to the slowest rate. **Therefore, if you don't want the displayed value to change rapidly, release the EDIT ▲ or EDIT ▼ key after the displayed value has changed by 8 or 9 counts.**

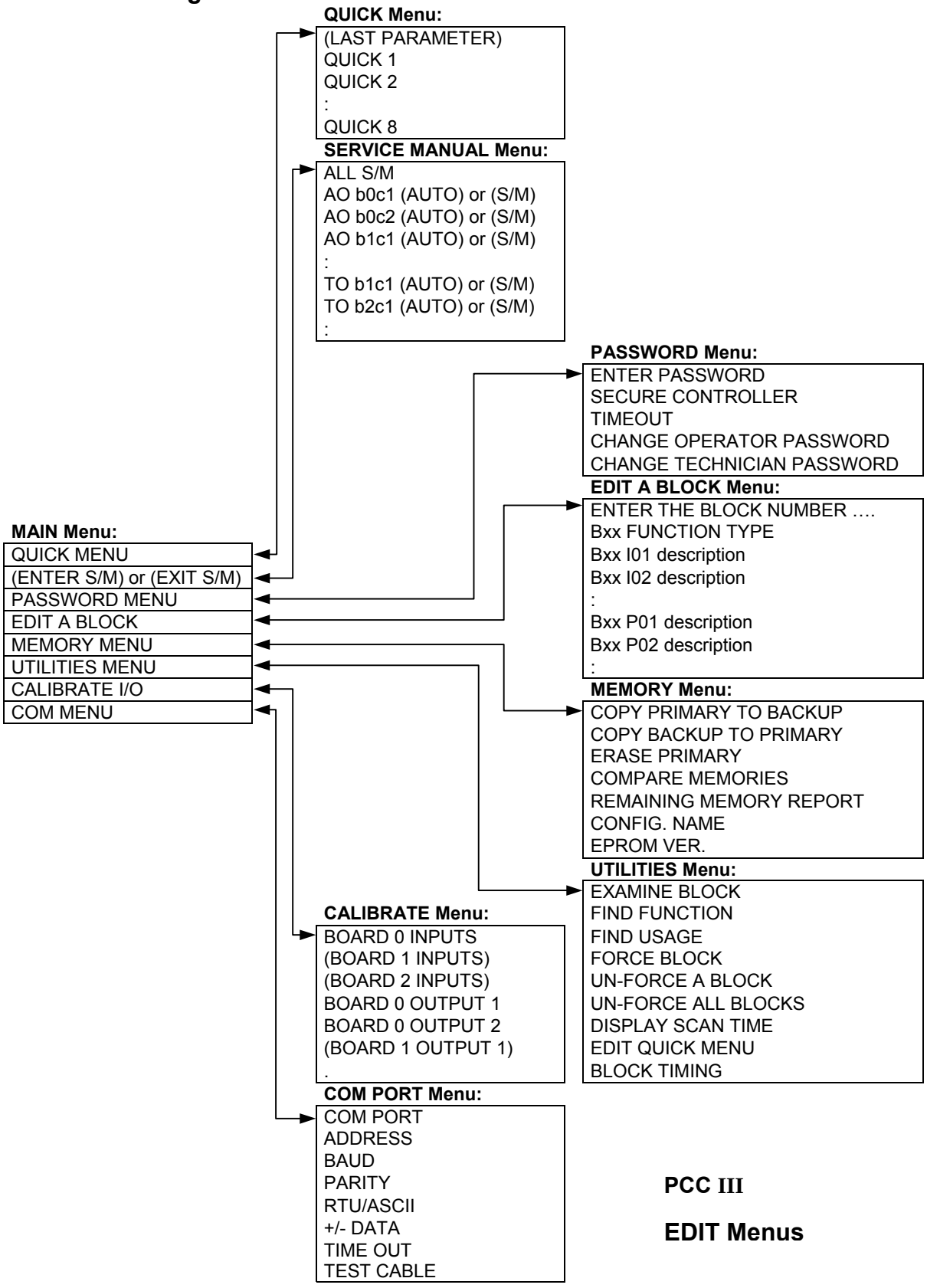
ENTER key

When the **Scroll Menu** light is Blinking, or when both display lights are OFF: The **ENTER** key activates the displayed EDIT Menu line item.
When the **Edit Value** light is blinking: The ENTER key stores the displayed number in the RAM and in the Primary Blockware EEPROM memories.

EDIT Menu Scrolling Example:
Starting from Process display mode, activate the EDIT menus, and change the AIN digital filter in Block 12, ENTER the value, and then exit the EDIT menus to re-activate the Process display channels. Asume Passwords are disabled.

Key Press	Message Display (after pressing key)	Scroll Menu Light	Numeric Display	Edit Value Light	Comment
	DRUM PSI		149		
EDIT	QUICK MENU				EDIT light turns ON
EDIT ▼	EXIT S/M				
EDIT ▼	PASSWORD				
EDIT ▼	EDIT A BLOCK				
ENTER	ENTER THE BLOCK NUMBER		4	Blink	Leave MAIN menu Enter EDIT A BLOCK menu
EDIT ▲	ENTER THE BLOCK NUMBER …		12	Blink	Press and hold, release when display shows "12"
ENTER	B12 AIN	Blink	2		"2" means Function Code Number 2, which is an AIN Function
EDIT ▼	B12 P01 OPTION BOARD ….	Blink	0		"B12 P01 …" means Block number 12, Parameter number 01, followed by a description
EDIT ▼	B12 P02 INPUT CHANNEL ….	Blink	2		
EDIT ▼		Blink			Scroll down through Parameters 03 thru 05
EDIT ▼	B12 P06 FILTER SECONDS	Blink	1.0		
ENTER	B12 P06 FILTER SECONDS		1.0	Blink	ENTER activates Edit Value
EDIT ▼	B12 P06 FILTER SECONDS		0.9	Blink	Change Value
EDIT ▼	B12 P06 FILTER SECONDS		0.8	Blink	
ENTER	B12 P06 FILTER SECONDS	Blink	0.8		Save new value in RAM and Primary EEPROM
ESC	ENTER THE BLOCK NUMBER …		12	Blink	you could scroll to a different Block number at this point
ESC	EDIT A BLOCK				
ESC	DRUM PSI		149		EDIT light turns OFF, Process mode displays re-activate
					After tuning is complete, COPY PRIMARY TO BACKUP

EDIT Menus Diagram



PCC III

EDIT Menus

MAIN Menu

QUICK MENU
(ENTER S/M) or (EXIT S/M)
PASSWORD MENU
EDIT A BLOCK
MEMORY MENU
UTILITIES MENU
CALIBRATE I/O
COM MENU

The Main Menu simply displays the names of all the other Menus contained in PCC III EDIT. The Main Menu provides the means to access the other Menus.

As described above, the **EDIT▲**and **EDIT▼** keys scroll the message display up and down within this Menu. The **ENTER** key activates the Menu that is currently being displayed on the message display. The **ESC** key terminates the EDIT Menus and returns the Front Panel displays to the Process Mode.

See the SERVICE MANUAL menu (pg. 4-7) for details on (ENTER S/M) or (EXIT S/M).

QUICK Menu

(LAST PARAMETER)
QUICK 1
QUICK 2
:
QUICK 8

The purpose of QUICK menu is to provide the user with rapid access to frequently used Blockware Parameters. Examples: PID Gain, High and Low alarm setpoints, equipment startup delay time, and warm-up ramp rate of change. The Quick Menu can have up to 9 lines: LAST PARAMETER and up to 8 QUICK selection line items. The QUICK menu line item descriptions, Block Numbers, and Parameter numbers are field configurable via: UTILITIES MENU \ EDIT QUICK MENU (see pg. 4-20)

Use the **EDIT ▲** or **EDIT ▼** keys to scroll to the desired QUICK menu line, then press **ENTER**. EDIT will jump into the EDIT A BLOCK menu, and attempt to display and edit the Parameter that was linked to the selected QUICK menu line item. If the Password level is correct, the Parameter value will be displayed, the Edit Value LED will be ON, and the **EDIT ▲** or **EDIT ▼** key can be used to change the value. Press **ENTER** or **ESC**. EDIT is now in the EDIT A BLOCK menu.

If the current Password is not at the correct level, or if S/M mode is required, then the Parameter cannot be edited, and an error message will be displayed. Press **ESC** to clear the error message, the Parameter value will then be displayed with the Edit Value LED turned OFF. EDIT is now in the EDIT A BLOCK menu.

LAST PARAMETER

This selection causes EDIT to jump to the last Parameter that was previously displayed. EDIT saves the LAST PARAMETER linkage automatically and retains the link even after leaving the EDIT mode.

Example: if you are tuning a PID Block and use the EDIT A BLOCK menu to change the PID Gain value, **ESC**ape out of the EDIT display mode into the Process display mode, observe the process response, and then re-activate EDIT. QUICK MENU will be the first MAIN menu line displayed, press **ENTER.** QUICK MENU \ LAST PARAMETER will be displayed, press **ENTER.** EDIT will then jump back to EDIT A BLOCK with the PID Gain displayed.

The LAST PARAMETER link is lost, and will not be displayed in the QUICK menu, after the PCC III powers down or re-boots. The LAST PARAMETER link is automatically re-established and will again be in the QUICK menu after a Parameter is displayed via either EDIT A BLOCK or another QUICK menu line item.

SERVICE MANUAL Menu

ALL S/M
AO b0c1 (AUTO) or (S/M)
AO b0c2 (AUTO) or (S/M)
AO b1c1 (AUTO) or (S/M)
:
TO b1c1 (AUTO) or (S/M)
TO b2c1 (AUTO) or (S/M)
:

What is "Service Manual" (S/M) Mode?

Normal Operation: During Normal Operation, an **AOUT** (or **TOUT**) Block converts a Blockware 0-100% Input signal into a proportional 4-20 mA (or Triac) hardware output every scan (1/10 second). Normal Operation continues uninterrupted, regardless of the Front Panel Display mode: Process mode, Annunciator mode, or EDIT mode.

Most PCC III controller Blockware control strategies have an "Auto / Manual" station on the Front Panel. During Normal Operation, BOTH "Auto" AND "Manual" modes rely on the field-configurable Blockware to regulate the

4-20 mA or Triac Output channels. "Manual" mode does NOT bypass the Output Channel Blockware (ie, AOUT or TOUT) and does NOT directly regulate the Output hardware.

Service Manual (S/M): During S/M mode a 4-20 mA (or Triac) Output channel is directly controlled using the permanently programmed firmware ROM, instead of the field-configurable Blockware logic. In fact, both the Primary and Backup Blockware memories can be erased or corrupted, and the Operator will still be able to manually regulate the PCC III 4-20 mA and Triac Outputs. The firmware ROM is factory programmed, and cannot be erased or corrupted by the user.

Relay Outputs and Sinking Discrete Outputs are always controlled by the Blockware. S/M mode has no effect on these.

When an Output channel enters S/M mode, the Output remains at the last value, unless the Operator uses the special S/M Front Panel display channels to change the Output.

The primary reason for using the Service Manual mode is to prevent the 4-20 mA and/or Triac Outputs from changing when the user is modifying the Blockware.

S/M mode can be activated from the SERVICE MANUAL menu on an individual, Output channel by Output channel basis. The Output channels can all be in Normal Operation mode, all in S/M mode, or in any combination of modes. However, PCC III will automatically put ALL Output channels into the S/M mode if any of the self diagnostic tests detect a problem.

PCC III will not de-activate S/M mode automatically. The user must manually de-activate S/M mode from the SERVICE MANUAL menu or from PC3_Edit.

RUN light indicates Normal, Forced, or S/M Mode

Green RUN Light ON / OFF Cycle	Operating Mode
ON Continuous OFF	Normal
ON 95% OFF Blinks OFF once every second	Forced Block(s) (pg. 4-19)
ON Blinks ON twice every second OFF 85%	Service Manual
ON OFF Continuous	Not Operating

Note: S/M Mode RUN light indication takes priority over FORCED Mode indication when both S/M and FORCED Modes are active.

WARNING

The PCC-III is commonly used to control potentially dangerous Combustion and Chemical Processes. VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) **BEFORE PUTTING THE PCC-III CONTROLLER INTO SERVICE MANUAL MODE.** FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

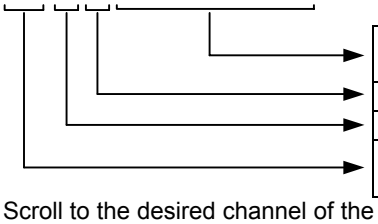
WHEN A PCC-III OUTPUT IS IN THE SERVICE MANUAL MODE, ALL BLOCKWARE IMPLEMENTED SAFETY LOGIC IS BYPASSED. THE OPERATOR HAS TOTAL RESPONSIBILITY TO INSURE THAT ALL EQUIPMENT IS OPERATED SAFELY.

ENTER S/M (in MAIN Menu)

The MAIN menu will display ENTER S/M if none of the Output channels are in S/M mode. Press **ENTER** if you want to put some or all of the Output channels into S/M mode.

ALL S/M
Pressing **ENTER** puts all of the 4-20 mA and Triac Output channels into S/M mode, and then automatically returns to the MAIN menu. The MAIN menu display will automatically change to EXIT S/M. The RUN light will start blinking.

AO b_c_ (AUTO) or (S/M)
TO b_c_ (AUTO) or (S/M)



AUTO	means this channel is currently in Normal Operation mode
S/M	means this channel is currently in S/M mode
c1, c2	Channel number, or Triac "Pair" number
b0, b1, b2	Board number: b0=CPU, b1=Option Slot 1, b2=Option Slot 2
AO	means this is an Analog Output (4-20 mA)
TO	means this is a Triac Output

Scroll to the desired channel of the desired Board, then Press **ENTER** to toggle between AUTO or S/M. At power-up, this menu is automatically re-configured to show only the Output types, channels, and boards that are actually installed. Press **ESC** to return to the MAIN menu. The MAIN menu display will automatically change to EXIT S/M. The RUN light will start blinking.

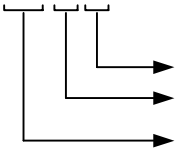
EXIT S/M (in MAIN Menu)
Pressing **ENTER** starts the Blockware error check routine. If no errors are detected, all of the 4-20 mA and Triac Output channels are put into Normal Operation mode. The MAIN menu display will automatically change to ENTER S/M. The RUN light will stop blinking.

If the Blockware error check detects an error, the message display will indicate the nature of the error and the Block that is causing the error. Press **EDIT ▼** to see if there are any additional errors. Press **ESC** when review of the error list is complete in order to return to the MAIN menu. The RUN light will continue to blink.

Changing an Output Value in S/M Mode
When an Output channel enters S/M mode, the Output is held at the last value. The Output will remain at the last value until the Operator changes the Output from the Front Panel.

Use **ESC** to exit the EDIT menus (EDIT light is OFF). Use the **DIS** key to scroll through the display channels until the desired S/M Output channel is displayed. S/M Output channel messages have the following format:

AO b_c_
TO b_c_



c1, c2	Channel number, or Triac "Pair" number
b0, b1, b2	Board number: b0=CPU, b1=Option Slot 1, b2=Option Slot 2
AO	means this is an Analog Output (4-20 mA)
TO	means this is a Triac Output

Use the ⇑, ⇓ keys to change the displayed S/M Output as follows:

AO (ie 4-20 mA) channels: The numeric display is 0-100% of 4-20 mA. 0% = 4 mA, 100% = 20 mA. The 4-20 vs. 20-4 Parameter in the AOUT Block does NOT change this scaling, 0% is always 4 mA.

TO (ie Triac) channels: The ⇑ key turns ON the T1 (i.e. "Increase") Triac of the selected pair. The ⇓ key turns ON the T2 (i.e. "Decrease") Triac of the selected pair.

If the Triacs are driving an actuator, do not depend on the S/M logic to indicate the actuator's position on the Numeric display. The Operator must independently observe the actuator's position and respond accordingly.

The S/M logic will attempt to find a **TOUT** Block that is assigned to the Triac channel being displayed, and display that assigned **TOUT** Block Output on the Numeric display. However, the displayed position is Blockware based, not S/M firmware based, therefore it can display an incorrect position if there are Blockware errors.

PASSWORD Menu

ENTER PASSWORD
SECURE CONTROLLER
TIMEOUT
CHANGE OPERATOR PASSWORD
CHANGE TECHNICIAN PASSWORD

The EDIT A BLOCK menu will display any and all data, regardless of the Password system status. However, if the Password system is enabled, the EDIT A BLOCK menu will not allow the user to modify Blockware data unless the active Password Level is acceptable.

As shipped from the factory, the PCC III Password system is disabled; therefore, the user can modify any data item in the PCC III.

Once a Password Level is activated, it will automatically deactivate after a Timeout period (30 minutes by default, 240 minutes max., see TIMEOUT menu item)

Password Levels

Level	Active Password	Service Manual (S/M) Mode
4	Factory	required
3	Technician	required
2	Technician	not required
1	Operator	not required

Section 6, "Blockware Functions - Technical Reference", specifies the minimum password level required to modify each individual Parameter of each Function Block available in the PCC III.

If Passwords are enabled, there are two generic EDIT A BLOCK editing tasks that require Password Level 3 or 4:

Modifying the Function Type of any Block.
Modifying an Input Block Number (ie, the Softwiring) within any Block.

Note: The above tasks still require S/M mode when Passwords are disabled.

Enabling the Password System

A Password is any number (except 0) between –19999 and +19999. To enable the Password system, a Technician Password must be configured; however, the Operator Password is optional. The Technician and Operator Passwords may be the same number.

To enable the Password system for the first time: First change the Technicians Password. Scroll to CHANGE TECHNICIAN PASSWORD, press **ENTER.** Use **EDIT ▲** or **EDIT ▼** to change the Numeric display to the desired Password. Write down the number that is being displayed, then press **ENTER**, "Password Changed" will be displayed. Press **ESC** to clear the message and return to the PASSWORD menu. EDIT is now Secured (that is, there is no active Password).

Enter the Technician Password: Scroll up to ENTER PASSWORD, press **ENTER.** Use **EDIT ▲** or **EDIT ▼** to change the Numeric display to the Technician Password that was entered in the previous step, then press **ENTER.** "Password Enabled" will be displayed, press **ESC** to clear the message and return to the PASSWORD menu. The Technician Password Level is now active.

Change the Operator Password: Scroll to CHANGE OPERATOR PASSWORD, press **ENTER.** Use **EDIT ▲** or **EDIT ▼** to change the Numeric display to the desired Password. Write down the number that is being displayed, then press **ENTER.** "Password Changed" will be displayed, press **ESC** to clear the message and return to the PASSWORD menu. EDIT is now Secured (that is, there is no active Password).

CAUTION

It is very important to write down the Technician and Operator Password numbers and keep this record in a convenient location. **DO NOT LOSE THE PASSWORDS. If the passwords are lost or forgotten, you will not be able to modify any of the Blockware data.** The Factory Password can be used to enter new passwords; however, this may require a billable service call to your site.

ENTER PASSWORD
This menu item is used to activate a Password Level.

Scroll to ENTER PASSWORD, press **ENTER.** Use **EDIT ▲** or **EDIT ▼** to change the Numeric display to the Password Number for the Level that you wish to activate, then press **ENTER.** "Password Enabled" will be displayed, press **ESC** to clear the message and return to the PASSWORD menu.

If an incorrect password is entered, "ERROR – INVALID PASSWORD" WILL BE DISPLAYED. Press **ESC** to clear the message and return to the PASSWORD menu.

SECURE CONTROLLER
Once a Password Level is activated, it will automatically deactivate after a Timeout period. However, the current Password Level can be de-activated before the Timeout by scrolling to SECURE CONTROLLER, and pressing **ENTER**. "Controller Secured" will be displayed, press **ESC** to return to the menu.

TIMEOUT
Once a Password Level is activated, it will automatically deactivate after a Timeout period. The default Timeout is 30 minutes. The Timeout can be changed to any value between 1 and 240 minutes. The Timeout is reset to 30 minutes every time the Password Level is deactivated (i.e. "Secured").

To change the Timeout: Scroll to TIMEOUT, press **ENTER.** Use **EDIT ▲** or **EDIT ▼** to change the Numeric display to the desired number of minutes, then press **ENTER.** Press **ESC** to return to the PASSWORD menu.

CHANGE OPERATOR PASSWORD
The Operator Password number can only be changed if the Password System is disabled, or if the active Password Level is at "Operator" or higher.

Scroll to CHANGE OPERATOR PASSWORD, press **ENTER.** Use **EDIT ▲** or **EDIT ▼** to change the Numeric display to the new Operator Password Number. Write down the number that is being displayed, then press **ENTER.** "Password Changed" will be displayed, press **ESC** to clear the message and return to the PASSWORD menu.

CHANGE TECHNICIAN PASSWORD
The Technician Password number can only be changed if the Password System is disabled, or if the active Password Level is at "Technician" or higher.

Scroll to CHANGE TECHNICIAN PASSWORD, press **ENTER.** Use **EDIT ▲** or **EDIT ▼** to change the Numeric display to the new Operator Password Number. Write down the number that is being displayed, then press **ENTER.** "Password Changed" will be displayed, press **ESC** to clear the message and return to the PASSWORD menu.

Disabling the Password System
Activate the Technician Password (follow the ENTER PASSWORD procedure above). Change the Technician Password to the number 0 (follow the CHANGE TECHNICIAN PASSWORD procedure above). Change the Operator Password to the number 0 (follow the CHANGE OPERATOR PASSWORD procedure above).

EDIT A BLOCK Menu

```
ENTER THE BLOCK NUMBER …
Bxx FUNCTION TYPE
Bxx I01 description
Bxx I02 description
:
Bxx P01 description
Bxx P02 description
:
```

This menu allows the user to display or modify all of the Blockware data in all 160 Blocks of the PCC III memory. This menu is used to:

Change the Function Type of a Block (**PID**, **AOUT**, …)
Connect Block Inputs to Block Outputs (ie, Softwiring)
Modify Parameters (ie, PID Gain, Alarm Setpoint, ..)

General

Do not attempt to use the EDIT A BLOCK menu until after you have read the complete Instruction Manual. The concepts in the following Sections are particularly important, and should be fully understood before modifying the Blockware:

Section 4	SERVICE MANUAL Menu
Section 4	PASSWORD Menu
Section 4	MEMORY Menu
Section 5	Configuring Blockware Control Strategies (the entire Section)
Section 6	Blockware Functions – Technical Reference (the entire Section)

WARNING

The PCC-III is commonly used to control potentially dangerous Combustion and Chemical Processes. VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) **BEFORE MODIFYING ANY OF THE BLOCKWARE DATA IN ANY BLOCK IN THE PCC-III MEMORY.** FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

WARNING

Data changes that are made during the use of the EDIT A BLOCK, CALIBRATE, and COM PORT menu items are saved in the Primary memory; however, these changes are NOT saved in the Backup memory. To insure that a future AutoLoad (ie, copy Backup into Primary) loads these changes, the user must copy the Primary memory into the Backup memory using the MEMORY \ COPY PRIMARY TO BACKUP menu item (pg 4-16). FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

The user should always refer to a Blockware schematic drawing when attempting to modify any aspect of the Blockware.

The PCC III Blockware executes continuously, including when the EDIT A BLOCK menu is being used. Any changes that are made will affect the Blockware as soon as the **ENTER** key is pressed.

The Function Type of any Block, the Input Softwiring of any Block, and the parameters in any Block can be displayed at any time. However, if the Password system is enabled (see pg 4-10), values can only be changed if the correct security password has been entered. Section 6, Blockware Functions – Technical Reference, for the password level required to change each Parameter.

The Function Type of a Block and the Input Softwiring of a Block can NOT be modified unless the PCC III is in Service Manual mode (see pg 4-8).

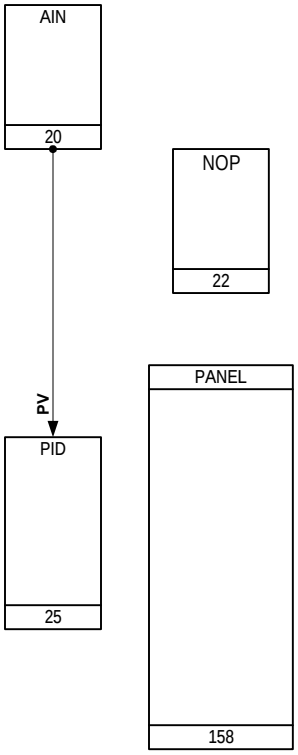
The number of items (ie, lines) in the EDIT A BLOCK menu depends on the Function Type in the Block that is being displayed. This menu has up to three groups of line items: Function Name, one line for each Input, and one line for each Parameter. However, some Functions (**AIN, DIN, CON,** …) have no softwired Inputs, so the Input line items would not exist. Other Functions don't have any Parameters (**HSEL, LSEL, AB/C,** …), so the Parameter line items would not exist. Section 6, Blockware Functions – Technical Reference, provides a detailed description of each Function Type.

Three sample EDIT A BLOCK menus are shown below. At left is the menu for an **AIN** Function in Block 4, in the center is the menu for an **AB/C** Function in Block 5, and at right is the menu for an **ASW** Function in Block 6.

B04 AIN B04 P01 OPTION BOARD … B04 P02 INPUT CHANNEL … B04 P03 VOLTS INPUT FOR 0% B04 P04 VOLTS INPUT FOR 100 B04 P05 SQ ROOT? 0=NO … : :	B05 AB/C B05 I01 A INPUT B05 I02 B INPUT B05 I03 C INPUT	B06 ASW B06 I01 A INPUT B06 I02 B INPUT B06 I03 SELECT INPUT B06 P01 XFER RATE LIMIT… B06 P02 A TO B %/SEC … B06 P03 B TO A %/SEC …

How to use EDIT A BLOCK, an Example

Assume that the Blockware shown at right already exists in memory. The designer wants to add a **HIALM** Function with a Setpoint of 75% in Block 22. Block 22 is currently a **NOP** Function, which means this Block is not being used. The designer wants the message "HI PSI" to appear on the Annunciator when a high alarm is acknowledged. The Ouput of Block 22 (**HIALM)** will be Softwired to Input 20 (Alarm Channel 1) of the **PANEL** Function in Block 158, and the "HI PSI" message will be entered into **PANEL** Parameter 42 (Alarm Channel 1 Message).



Change Block 22 from a NOP to a HIALM Function

ENTER S/M mode (see pg 4-8)
ENTER PASSWORD, Technician Level, if enabled (see pg 4-11)
Scroll to EDIT A BLOCK in the MAIN menu, press **ENTER**
"ENTER THE BLOCK NUMBER TO BE EDITIED" will be displayed
Use **EDIT ▲** or **EDIT ▼** to set the Numeric display to 22 (ie, Block number 22), press **ENTER**
"B22 NOP" and "127" will be displayed. "B22" means "Block 22", "NOP" is the Function Name currently in this Block, "127" is the Function Code Number for a "NOP" Function. The Scroll Menu light will blink (see pg 4-1).
Press **ENTER** to change from Scroll Menu to Edit Value mode. Scroll Menu light turns off, Edit Value light will blink.
NOTE: If **ENTER** is accidently pressed a second time, "REPLACE f127 WITH f127 ENTER=YES" will be displayed. Press **ESC**, then press **ENTER**.
Use **EDIT** ✱ to scroll down through the available Function Code Numbers until "B22 HIALM" and "101" are displayed.
NOTE: While the scrolling is changing the Function Code Number on the Numeric display, it is simultaneously changing the Function Name on the Message display. In fact, the Function Number can almost be ignored, and the Function Name display can be used as the primary indicator.
NOTE: At this point, pressing **ESC** would return the display to "B22 NOP", and Block 22 would remain as it was before any changes were attempted. For this example, do not press **ESC** .
When "B22 HIALM" and "101" are displayed, press **ENTER**.
Block 22 is now a HIALM Function. Scroll Menu light will blink, Edit Value light turns off.
NOTE: When EDIT A BLOCK changes the Function Type of a Block, it automatically does the following:
Softwires Block 0 (Function **A0**, the 0% constant) to all Analog Inputs.
Softwires Block 2 (Function **D0**, the Discrete "0" constant) to all Discrete Inputs.
Sets each Parameter to it's "Default" value as defined in Section 6.

Softwire the HIALM Block "PV" Input

The "PV" Input (Input channel 1, see Section 6) will be "Softwired" (ie, configured) to monitor the Block Ouput signal of the **AIN** Function in Block 20 in this example.

Continuing from the previous example, "B22 HIALM" is displayed, S/M mode is active, and Technician Password Level is active. Scroll Menu light should be blinking. If Edit Value light is blinking, Press **ESC**, Scroll Menu light will then blink.

Press **EDIT ▼** to scroll to "B22 I01 PV INPUT". "B22" means "Block 22", "I01" means "Input Channel 1", and "PV INPUT" describes the purpose of this Input Channel. The Numeric display will indicate the Block number that is currently Softwired to this Input Channel.

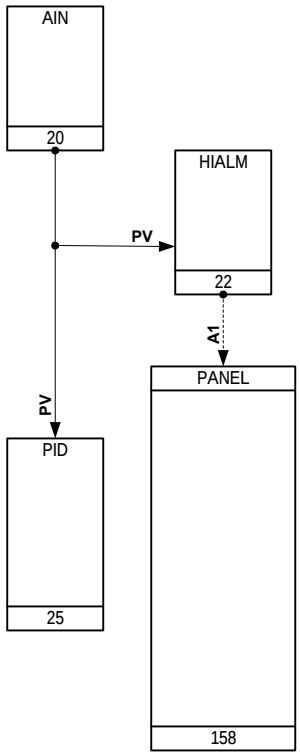
Press **ENTER** to change from Scroll Menu to Edit Value mode. Scroll Menu light turns off, Edit Value light will blink.

Use **EDIT ▲** or **EDIT ▼** to set the Numeric display to 20. "20" means that Input Channel 1 is going to be Softwired to the Output of Block 20.

NOTE: At this point, pressing **ESC** would return EDIT A BLOCK to Scroll Menu mode and the Softwiring would remain as it was before any changes were attempted. For this example, do not press **ESC** .

Press **ENTER**

Block 20 is now Softwired to Block 22, Input 1. Scroll Menu light will blink, Edit Value light turns off.



Change the HIALM Setpoint Parameter

Change Parameter 3, the Internal Setpoint, from the default value of 50% to the desired 75% as follows:

Continuing from the previous example, "B22 I01 PV INPUT" is displayed, S/M mode is active, and Technician Password Level is active. Scroll Menu light should be blinking. If Edit Value light is blinking, Press **ESC**, Scroll Menu light will then blink.

This particular Parameter can modified at Password Level 1 (Operator Level without S/M mode), however, it is good practice to stay in S/M mode, and the higher Technician Level can be used for the lower Operator Level.

Scroll down to "B22 P03 % INT SP". "B22" means "Block 22", "P03" means "Parameter 3", and "% INT SP" describes the purpose of this Parameter. The Numeric display will indicate the current value of this Parameter.

Press **ENTER** to change from Scroll Menu to Edit Value mode. Scroll Menu light turns off, Edit Value light will blink.

Use **EDIT ▲** or **EDIT ▼** to set the Numeric display to 75.00 (75.00%).

NOTE: At this point, pressing **ESC** would return EDIT A BLOCK to Scroll Menu mode and the Parameter value would remain as it was before any changes were attempted. For this example, do not press **ESC** .

Press **ENTER**

Block 2, Parameter 3 (the Internal Setpoint) is now set to 75.00%. Scroll Menu light will blink, Edit Value light turns off.

Softwire the PANEL "Alarm Channel 1" Input

The "Alarm Channel 1" Input (Input channel 20, see Section 6) of the **PANEL** Function in Block 158 will be "Softwired" (ie, configured) to monitor the Block Ouput signal of the **HIALM** Function in Block 22 in this example. See "Softwire the HIALM Block "PV" Input" above for more detailed comments, the instructions below are shortened fro brevity.

Continuing from the previous example, "B22 P03 % INT SP" is displayed, S/M mode is active, and Technician Password Level is active. Scroll Menu light should be blinking. If Edit Value light is blinking, Press **ESC**, Scroll Menu light will then blink.

Press **ESC** to exit the EDIT A BLOCK menu for Block 22.

"ENTER THE BLOCK NUMBER TO BE EDITIED" will be displayed

Use **EDIT ▲** or **EDIT ▼** to set the Numeric display to 158 (ie, Block number 158), press **ENTER**

"B158 PANEL" and "96" will be displayed.

Scroll down to “B158 I20 ALM CH 1”
Press **ENTER** to change from Scroll Menu to Edit Value mode. Scroll Menu light turns off, Edit Value light will blink.
Use **EDIT ▲** or **EDIT ▼** to set the Numeric display to 22 (ie, block 22, **HIALM**)
Press **ENTER**
Block 22 is now Softwired to Block 158, Input 20. Scroll Menu light will blink, Edit Value light turns off.

Entering a “Message” Parameter in PANEL

All of the Softwiring and Parameter editing involved changing Numeric values. The **PANEL** Function has Parameters that are (up to) 16 character alphanumeric messages. The Numeric display can not display “A-Z”, so a different editing technique is required to enter or modify a message Parameter. Proceed as follows:

Continuing from the previous example, “B158 I20 ALM CH 1” is displayed, S/M mode is active, and Technician Password Level is active. Scroll Menu light should be blinking. If Edit Value light is blinking, Press **ESC**, Scroll Menu light will then blink.
Scroll down to“B158 P42 ALM CH 1 MESSAGE”
Press **ENTER**
The Message display will change from “B158 P42 ALM CH 1 MESSAGE” to the existing message
The “cursor” position is indicated by alternating between the existing character and an underline.
Use **EDIT ▲** or **EDIT ▼** to scroll through the available characters (A-Z, 0-9, %, *, /, ….)
When the desired character is displayed DO NOT PRESS **ENTER,**
Press the **DIS** key to move the “cursor” one position to the right
Repeat this process until up to 16 characters have been selected
Press **ENTER** after the entire message has been composed
The Message display returns to the menu (ie, “B158 P42 ALM CH 1 MESSAGE”).

MEMORY Menu

COPY PRIMARY TO BACKUP
COPY BACKUP TO PRIMARY
ERASE PRIMARY
COMPARE MEMORIES
REMAINING MEMORY REPORT
CONFIG. NAME
EPROM VER.

The CPU board has two separate non-volatile EEPROM memories we refer to as “Primary” and “Backup”. Each memory contains Blockware data, Calibration data, and Communications setup data. Normally, the Primary and Backup memories contain duplicate copies of this data.

AutoLoad

During normal operation, the CPU uses the Primary memory. In the unlikely event that a large electrical surge corrupts the Primary memory, the CPU will automatically re-boot and attempt to “AutoLoad” the entire contents of the Backup memory into the Primary memory. If the Backup memory is OK, the controller will automatically resume operation. “AutoLoad” copies all Blockware, Calibration, COM PORT, and Retentive Memory data from the Backup into the Primary memory.

WARNING

Data changes that are made during the use of the EDIT A BLOCK, CALIBRATE, and COM PORT menus are saved in the Primary memory. However, these changes are NOT saved in the Backup memory. To insure that a future AutoLoad (ie, copy Backup into Primary) loads these changes, the user must copy the Primary memory into the Backup memory using the MEMORY \ COPY PRIMARY TO BACKUP menu item (pg. 4-16). FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

When changes are being made to existing, operational Blockware logic, the changes should be completely debugged, and tested **before** they are copied to the Backup memory. If the changes do not work as desired, the COPY BACKUP TO PRIMARY menu item can be used to load the original logic back into the Primary memory.

Backup Memory Write Protect Jumper

In order to prevent corruption of the Backup memory, the Backup has a “Write Protect” jumper on the CPU board (see pg. 2-7). The Write Protect jumper should be in the “WP” (ie Write Protect) position at all times during normal operation. However, the Write Protect Jumper must be moved to the “R/W” (ie, Read / Write) position before using the COPY PRIMARY TO BACKUP menu item. The jumper must then be moved back to the “WP” position after completing the Copy process.

Backup Memory Socket

Both the Primary and Backup memories are non-volatile EEPROM memory chips that will retain their contents for over 20 years without power and they do not rely on batteries. The Backup memory is plugged into a lever operated Zero Insertion Force (ZIF) socket.

The Backup memory chip can be easily removed from the PCC III, and it will retain it's contents. **DO NOT REMOVE OR INSTALL THE BACKUP MEMORY CHIP WHEN POWER IS APPLIED TO THE PCC III.**

These features can be used in several ways:

Copy Blockware from one PCC III into a second PCC III: If you have two boilers or process units that are identical, after the start-up of the first unit is completed, COPY PRIMARY TO BACKUP, power down, remove the Backup memory chip and install it in the second unit (with power OFF). COPY BACKUP TO PRIMARY, and then start debugging and testing the second unit. This saves time and can be accomplished without any special equipment.

COPY PRIMARY TO BACKUP

This menu item copies the entire contents of the Primary memory into the Backup Memory. This includes all Blockware, Calibration, COM PORT, and Retentive Memory data.

Remove the Front Panel and move the Backup Memory Write Protect Jumper to the "R/W" position (see pg. 2-7). Scroll to COPY PRIMARY TO BACKUP, Press **ENTER.** "Press ENTER to save primary" is displayed. Press **ENTER** to proceed (or **ESC** to return to the menu). If **ENTER** was pressed, "busy" will be displayed for several seconds, followed by "backup complete". Press **ESC** to return to the menu and move the Backup Memory Write Protect Jumper to the "WP" position. Re-install the Front Panel.

The error message "ERROR – UNABLE TO UPDATE BACKUP" will be displayed if the Write Protect Jumper is in the wrong position, or the Backup memory is not properly inserted into the socket

COPY BACKUP TO PRIMARY

This menu item copies the Blockware, and COM PORT data from the Backup into the Primary memory. Calibration, Retentive, and Password data is NOT copied into the Primary, because it is hardware specific and the Backup chip could contain Calibration data from a different set of hardware.

The PCC III will not COPY BACKUP TO PRIMARY unless ALL of the 4-20 mA and Triac Output channels are in Service Manual mode (see pg. 4-9).

WARNING

The PCC-III is commonly used to control potentially dangerous Combustion and Chemical Processes. VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) **BEFORE PUTTING THE PCC-III CONTROLLER INTO SERVICE MANUAL MODE.** FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

WHEN A PCC-III OUTPUT IS IN THE SERVICE MANUAL MODE, ALL BLOCKWARE IMPLEMENTED SAFETY LOGIC IS BYPASSED. THE OPERATOR HAS TOTAL RESPONSIBILITY TO INSURE THAT ALL EQUIPMENT IS OPERATED SAFELY.

THIS OPERATION COMPLETELY OVERWRITES THE EXISTING BLOCKWARE LOGIC IN LESS THAN 1/10 SECOND AND WILL CAUSE RELAY AND SINKING DISCRETE OUTPUTS TO CHANGE STATE UNPREDICTABLY.

Scroll to COPY BACKUP TO PRIMARY, Press **ENTER.** "Press ENTER to restore primary" is displayed, Press **ENTER** to proceed (or **ESC** to return to the menu). If **ENTER** was pressed "busy" will be displayed for several seconds, followed by "primary restored". Press **ESC** to return to the menu.

The error message "ERROR ALL OUTPUTS MUST BE IN S/M" will be displayed if this menu item is selected before putting all Outputs into S/M mode. Press **ESC** to return to the menu.

The error message “ERROR BAD BACKUP CHECKSUM” will be displayed if the Backup Memory is bad. The Backup data will not be copied into the Primary memory. Press **ESC** to return to the menu.

After completing the COPY BACKUP TO PRIMARY operation, it is necessary to use the COPY PRIMARY TO BACKUP menu item to insure that the Backup Memory contains the Calibration data that is specific to this particular set of hardware.

After the new Blockware has been debugged and tested, EXIT S/M.

ERASE PRIMARY

This menu item erases all of the Blockware. It does this by setting every Block to a **NOP** Function.

The PCC III will not ERASE PRIMARY unless ALL of the 4-20 mA and Triac Output channels are in Service Manual mode (see pg. 4-9).

WARNING

The PCC-III is commonly used to control potentially dangerous Combustion and Chemical Processes. VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) **BEFORE ERASING THE PRIMARY MEMORY.** FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

Scroll to ERASE PRIMARY, Press **ENTER.** “Press ENTER to erase primary” is displayed. Press **ENTER** to proceed (or **ESC** to return to the menu). If **ENTER** was pressed “busy” will be displayed for several seconds, followed by “primary erased”. Press **ESC** to return to the menu.

The error message “ERROR ALL OUTPUTS MUST BE IN S/M” will be displayed if this menu item is selected before putting all Outputs into S/M mode. Press **ESC** to return to the menu.

COMPARE MEMORIES

This menu item compares the Blockware, Calibration, and COM PORT data in the Primary and Backup memories and indicates if the two memories “match” (i.e., are the same) or are “mismatched” (i.e., are different).

Scroll to COMPARE MEMORIES, Press **ENTER.** Either “memories match” or “memories mismatch” will be displayed. Press **ESC** to return to the menu.

REMAINING MEMORY REPORT

This menu item displays the amounts of “FREE” (ie unused) Blockware memory in three categories: DATA, TEMP, and RETENTIVE. Section 6 details the quantity of each type of memory that each Blockware Function requires.

Press **EDIT ▼** succesively to display the current values for each of the following catagories:

Message:	Maximum Available:
REMAINING RETENTIVE WRITES x1000	570,000 (displayed as 0-570)
FREE DATA BYTES	5120
FREE TEMP BYTES	1280
FREE RETENTIVE BYTES	58

Press **ESC** to return to the MEMORY menu.

CONFIG. NAME

This menu feature has not been activated at this time.

EPROM VER.

This menu item displays the software version of the ROM firmware, the date that the version was released, and an EEPROM memory map structure code.

Scroll to EPROM VER., Press **ENTER.** The Version information will be displayed. Press **ESC** to return to the menu.

UTILITIES SUB-MENU

EXAMINE BLOCK
FIND FUNCTION
FIND USAGE
FORCE BLOCK
UN-FORCE A BLOCK
UN-FORCE ALL BLOCKS
DISPLAY SCAN TIME
EDIT QUICK MENU
BLOCK TIMING

This menu provides a variety of tools for trouble-shooting, information display, and QUICK menu setup.

EXAMINE

The concept of Blockware and Softwiring the Output of one Block to the Input of a second Block is the direct software equivalent of physically hardwiring from one electronic signal processing module to another. Trouble-shooting a hardwired system is done with a Voltage / Current multi-meter. The EXAMINE menu item is the software equivalent of the physical multi-meter.

The EXAMINE menu item allows you to select any Block, and to display the real time Output of that Block. In addition, EXAMINE can display the real time value of each Input signal for that Block.

Analog signals from –199.99% to +199.99% can be displayed; however, Blockware is normally designed to use a 0-100.00% range. Block Outputs are percentages. The Block output values are not scaled in engineering units rather it is the **PANEL** Block that performs the engineering units scaling for the Front Panel displays.

Discrete signals are displayed as “1” or “0”.

A signal can easily be traced from the initial **AIN** Block, to the next Block, to the next, and finally to the **AOUT** Block. When an improper signal is found, the preceding Blocks are then checked for incorrect Parameter values, or incorrect Softwiring (e.g., the Input should come from Block 17, but was accidentally entered as Block 18). Referring to a Blockware drawing that shows all of the Block Softwiring (ie, interconnections) for the controller is strongly recommended.

EXAMINE Block Outputs

Scroll to the EXAMINE menu item, press **ENTER.** Scanning up from Block number 4, EXAMINE will display the Output of the first Block that is not a **NOP.** Use the **EDIT ▲** or **EDIT ▼** keys to scroll to the Output of any other Block.

EXAMINE will skip over any Blocks that contain a **NOP**. The Numeric display will show the current Output Value. The Message display will show the Block number as “Bxxx”, and will show the Name of the Function contained in that Block.

EXAMINE the Input Signals of a Block

First display the Block Output of the desired Block as described above in “EXAMINING Block Outputs”. Press **ENTER** to display the current value of the first Input. The Numeric display will show the Input value. The Message display will show “Bxxx Iyy”, followed by the Input Name. “xxx” will be the Block Number, “yy” will be the Input Number.

Use **EDIT ▼** to scroll down to display any other Input channels that might be present. Press **ESC** to return to the Block Output display mode (“Bxxx Function Name” is displayed, instead of “Bxxx Iyy Input Name”). Use **EDIT ▲** to scroll up through the available Input channels. Scrolling up past the first Input channel will return EXAMINE to the Output display mode.

FIND FUNCTION

The Blockware designer has the freedom to put any Function Type into any Block number. If the Blockware Schematic drawing or the Blockware tabular data print-out is not available, it can be time consuming to EXAMINE every Block to locate a Function Type.

Using FIND FUNCTION, any particular Function Type can be rapidly located.

Scroll to FIND FUNCTION, press **ENTER.** “127” and “ENTER FUNCTION NUMBER” will be displayed. Use **EDIT ▼** to scroll down to the Function Number / Function Name that you want to locate, press **ENTER**.

FIND FUNCTION starts searching at Block 4, and scans up to Block 159. If the Function is found in a Block, “Bxxx” followed by the Function Name will be shown on the Message display. The Numeric display is not meaningful and should be ignored.

FIND USAGE

Softwiring is accomplished by scrolling to the Input channel of a Block (ie, the signal "Destination"), and entering the Block number of the signal "Source". Said in another way, Softwiring is accomplished by scrolling to the Destination and selecting a Source for the Input.

FIND USAGE will locate every Destination (ie Block Input) that is using a particular Source Block's Output.

Scroll to FIND USAGE, press **ENTER.** "ENTER BLOCK NUMBER" will be displayed. Use **EDIT ▲** or **EDIT ▼** to display the desired Source Block Number, press **ENTER.** Searching begins at Block 4, and scans up, "Bxxx Iyy" followed by the Input Name will be displayed. To continue searching the remainder of the Blocks, press **EDIT** ⍋. Press **EDIT ▲** or **EDIT ▼** to re-display the Block Inputs that were found. Press **ESC** to return to the MAIN menu.

If no Block Inputs were found, "NOT USED" will be displayed. Press **ESC** to return to the MAIN menu.

Forcing Block Outputs

As an aid to trouble-shooting and field wiring check-out, PCC III Block Outputs can be temporarily "FORCED" to remain at a user selected, fixed value. When **AOUT, TOUT, DOUT,** or **ROUT** Block Outputs are FORCED, the hardware Outputs will be set to the equivalent value (see also "Forcing **TOUT** in Dual Triacs Mode").

WARNING

The PCC-III is commonly used to control potentially dangerous Combustion and Chemical Processes. **Block Outputs should only be FORCED on a short term, temporary basis under the direct, continuous supervision of a qualified technician who is familiar with the operation of the entire control system.** FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

The FORCE data …ie, FORCED Block number(s) and the Output value(s)… is stored in RAM, it is NOT stored in the Blockware EEPROM memories. **Therefore, after every power interruption, or any other PCC III CPU re-start, all FORCED blocks will revert to UN-FORCED.**

RUN light indicates Normal, Forced, or S/M Mode

Green RUN Light ON / OFF Cycle		Operating Mode
ON OFF	Continuous	Normal
ON OFF	95% Blinks OFF once every second	Forced Block(s) (pg. 4-19)
ON OFF	Blinks ON twice every second 85%	Service Manual
ON OFF	Continuous	Not Operating

Note: S/M Mode RUN light indication takes priority over FORCED Mode indication when both S/M and FORCED Modes are active.

FORCE BLOCK

Scroll to FORCE BLOCK, press **ENTER.** "ENTER BLOCK NUMBER" will be displayed. Use **EDIT ▲** or **EDIT ▼** to display the desired Block Number, press **ENTER.** "Bxx" followed by the Function Name will be displayed and the "Edit Value" light will be blinking. Use **EDIT ▲** or **EDIT ▼** to set the desired Block Output Value, press **ENTER.** The display returns to the menu.

The RUN light will start blinking as noted above, unless S/M mode is active.

Repeat the above for each Block to be FORCED. Multiple Block Outputs can be simultaneously FORCED.

UN-FORCE A BLOCK
This menu item returns a single Block to Normal Operation (ie, UN-FORCED).

Scroll to UN-FORCE A BLOCK, press **ENTER.** "ENTER BLOCK NUMBER" will be displayed. Use **EDIT ▲** or **EDIT ▼** to display the desired Block Number, press **ENTER.** "Block Released" will be displayed and the Block will be UN-FORCED. Press **ESC** to return to the menu.

UN-FORCE ALL BLOCKS
This menu item returns ALL Blocks to Normal Operation (ie, UN-FORCED).

Scroll to UN-FORCE ALL BLOCKS, press **ENTER.** "PRESS ENTER TO RELEASE OUTPUTS" will be displayed, press **ENTER** to continue. The display returns to the UN-FORCE ALL BLOCKS menu item.

DISPLAY SCAN TIME
This menu item displays the number of milliseconds required to execute the Blocks. The PCC III executes all of the Blocks in no less/more than 10 times per second (100 ms). The Block SCAN TIME is typically 10-50 ms, and the PCC III "fills" the remaining time with a delay loop.

In the unlikely event that the SCAN TIME is greater than 100 ms, the PCC III will always complete the execution of all blocks.

Scroll to DISPLAY SCAN TIME, press **ENTER.** The milliseconds will be displayed. Press **ESC** to return to the menu.

EDIT QUICK MENU
This menu item provides the means to enter and edit the QUICK menu messages, Block number pointers, and Parameter number pointers. See page 4-7 for an explanation of how to use the QUICK menu.

Scroll to EDIT QUICK MENU, press **ENTER.** The sub-menu shown at the right is activated. This menu has 24 line items: "Qx MSG", "Qx BLK", and "Qx PARAM" for each of the eight QUICK menu items.

Q1 MSG
Q1 BLK
Q1 PARAM
Q2 MSG
Q2 BLK
:
.

EDIT QUICK MENU Line Items

"Qx MSG" is the 1-16 character message that will be displayed when the user scrolls to line "x" of the QUICK menu. If the user presses **ENTER** (in the QUICK menu), the QUICK menu display will change to the EDIT A BLOCK menu and will be pre-positioned at the Block number specified by "Qx BLK", at the Parameter number specified by "Qx PARAM".

Refer to Section 6, "Blockware Functions – Technical Reference", to find the Parameter numbers for each Function.

Example: The Blockware designer wants QUICK Menu line 2 to display "PID Repeats/Min", and line 2 to "Point" to the **PID** Function in Block 32. "Repeats/Min" is Parameter number 2 of the PID function. Use EDIT QUICK MENU to enter the following data:

Q2 MSG	"PID REPEATS/MIN"
Q2 BLK	32
Q2 PARAM	2

Entering a Message
Scroll to Qx MSG, Press **ENTER**, The Message display will change from "Qx MSG" to the existing message. The "cursor" position is indicated by alternating between the existing character and the underlined character. Use **EDIT ▲** or **EDIT ▼** to scroll through the available characters (A-Z, 0-9, %, *, /, ….). When the desired character is displayed DO NOT PRESS **ENTER,** press the **DIS** key to move the "cursor" one position to the right. Repeat this process until up to 16 characters have been selected. Press **ENTER** after the entire message has been composed. The display will return to the menu.

Entering the Block Number
Scroll to Qx BLK, Press **ENTER.** "Qx Byyy" followed by the Function Name will be displayed along with "yyy" on the Numeric display. The Edit Value light will be blinking. Use **EDIT ▲** or **EDIT ▼** to display the desired Block

Number, press **ENTER.** The display returns to the menu with "Qx BLK" displayed along with the Block Number shown on the Numeric display.

Entering the Parameter Number

Scroll to Qx PARAM, Press **ENTER.** "Qx Byyy Pzz" followed by the Parameter Name will be displayed along with "zz" on the Numeric display. The Edit Value light will be blinking. Use **EDIT ▲** or **EDIT ▼** to display the desired Block Number, press **ENTER.** The display returns to the menu with "Qx PARAM" displayed along with the Parameter Number shown on the Numeric display.

NOTE: "zz" is the Parameter number, it is not the value stored in this Parameter location. For example "Repeats/MIN" is **PID** Parameter number 2, while the value stored might be 3.50.

BLOCK TIMING

This menu item displays the number of microseconds required to execute a particular Block.

Scroll to BLOCK TIMING, press **ENTER.** "ENTER BLOCK NUMBER" will be displayed. Use **EDIT ▲** or **EDIT ▼** to display the desired Block Number, press **ENTER.** "Bxx" followed by the Function Name will be displayed and the Numeric display will show the execution time in microseconds. Press **ESC** to return to the menu.

CALIBRATE Menu

BOARD 0 INPUTS
(BOARD 1 INPUTS)
(BOARD 2 INPUTS)
BOARD 0 OUTPUT 1
BOARD 0 OUTPUT 2
(BOARD 1 OUTPUT 1)
.

This menu item allows the user to calibrate the Analog Inputs (0-5 Vdc) and the Analog Ouputs (4-20 mA). All PCC III controller Analog Inputs and Analog Ouputs are factory calibrated per the chart below.

Board Type:	Input or Output	Factory Calibration Tolerence
All	Input	+/-0.0005 V or 0.013% of 4 V
All	Output	+/-0.003 mA or 0.019% of 16 mA

When is Calibration Required?

Typically, a PCC III will not require field calibration for the life of the controller.

There are two reasons to field calibrate all or part of the PCC III: An Option Board is installed in the field, or the factory calibration data is corrupted.

Option Board installed in the field: Because factory calibration data is not in the CPU Board EEPROM memory, the PCC III uses default calibration data to allow operating the new option board without factory calibration data. The default data reduces the gauranteed accuracy as shown below. If this accuracy is acceptable, the new Option Board does not have to be calibrated.

Board Type:	Input or Output	Worst Case Accuracy when using Default Calibration Data
CPU, A, F, or G	Input	+/-10 mV or 0.25% of 4 V
B	Input	+/-50 mV or 1.25% of 4 V
CPU or F	Output	+/-0.05 mA or 0.3% of 16 mA

NOTE: This chart only applies to field installed Option Boards that have NOT been calibrated. Factory installed Option Boards are calibrated as noted above.

The above chart reflects thoretical, worst case accuracy data. Typically, the default data provides much higher accuracy than the chart shows. Input voltage accuracy can be checked by measuring the input voltage, converting it to a percentage (based on **AIN** Block scaling), and comparing the result to the **AIN** Block Output value as shown by the EXAMINE menu item (see pg 4-18). Output accuracy can be checked by putting the Output into S/M mode (see pg 4-9) and comparing the measured mA output to the percentage displayed by the EXAMINE menu item.

Factory calibration data is corrupted: While unlikely, it is possible for an electrical surge to corrupt the Blockware or Calibration data. If the Primary memory was copied to backup, then the calibration data would AutoLoad from

the Backup memory (see pg 4-15). However, if the Backup memory was not a duplicate of the Primary, then the calibration data may not pass the validation tests preformed at start-up.

If neither the Priamary nor the Backup contains valid calibration data, then the PCC III will use default calibration data and continue operating with the reduced accuracy as described above.

Analog Inputs Calibration Status Display

The Analog to Digital (A/D) converter calibration status of each Board is displayed during the Power Up Self Test messages as "A/D x yy". "x" indicates the Board number (CPU displays as a blank, "1"= Option Board 1, "2" = Option Board 2). "yy" will be either "OK" or "SC", "SC" stands for Self Calibration (ie, defaut calibration data).

WARNING

The PCC-III is commonly used to control potentially dangerous Combustion and Chemical Processes. VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) **BEFORE CALIBRATING THE PCC III.** FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

WARNING

Data changes that are made during the use of the EDIT A BLOCK, CALIBRATE, and COM PORT menu items are saved in the Primary memory; however, these changes are NOT saved in the Backup memory. To insure that a future AutoLoad (ie, copy Backup into Primary) loads these changes, the user must copy the Primary memory into the Backup memory using the MEMORY \ COPY PRIMARY TO BACKUP menu item (pg 4-16). FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

Analog Input Calibration Procedure

This procedure requires a low noise voltage source that can produce 2.500 Vdc and 5.000 Vdc, and a DC Voltmeter to measure the calibration voltages to within +/- 0.4 mV. This means that the DC Voltmeter must display at least “5 ½ digits” (ie, 19.9999). However, not all 5 ½ digit Voltmeters have +/- 0.4 mV accuracy, depending on the accuracy specification of the meter, a 6 ½ digit meter may be required.

Most portable test meters and voltage calibrators have 4 ½ digits or less of display resolution. “Calibrating” the PCC III with a less than 5 ½ digit DC Voltmeter will result in lower PCC III accuracy.

This procedure applies to the CPU Board (Board 0), Option Board 1, and Option Board 2. Using the CPU Board will be used as an example, the procedure is as follows:

ENTER S/M for ALL Outputs (see pg 4-9).
Remove all field wiring from all of the Analog Input channels on the Board to be calibrated. Alternatively, un-plug the field wiring connector, and plug-in a spare field wiring connector.
Wire all of the “+” terminals of all of the channels together, to the Voltage Source, and to the Voltmeter (see Section 2 for terminal numbers).
Wire all of the “-” terminals of all of the channels together, to the Voltage Source, and to the Voltmeter.
Disconnect (ie, switch OFF or remove the jumper) all 250 ohm resistors.
Scroll to BOARD 0 INPUTS
Press **ENTER,** “APPLY 2.500 VOLTS SIGNAL TO CHANNELS 1 – x, THEN PRESS ENTER” will be displayed.
The error message "MUST BE IN S/M TO CALIBRATE" will be displayed if ALL of the Outputs are NOT in S/M mode (see pg 4-9)
Set the Voltage Source to 2.5000 Vdc, +/-0.0005 Vdc.
Press **ENTER**
"filter settling" will be displayed for 10 sec to allow the hardware low pass filter capacitors to charge up.
"busy" will then be displayed for 15 sec while the 2.5 V calibration is attempted.
The error message "CALIBRATION ABORTED, CHANNEL x OUT OF RANGE +/- yyyyyy" will be displayed if: the Voltage Source is not at the correct voltage, a 250 ohm resistor is connected to the input, the Voltage Source is noisy, or the A/D has out of tolerance parts. "yyyy" indicates the magnitude of the error, and is used by factory technicians for

diagnostics, values can be 6000 and higher. Press **ESC** to return to the menu, the original calibration will still be in effect.

"APPLY 5.000 VOLT SIGNAL TO CHANNELS 1 – x, THEN PRESS ENTER" will be displayed if the 2.5 V calibration was successful.

Set the Voltage Source to 5.0000 Vdc, +/-0.0005 Vdc.

Press **ENTER**

"filter settling" will be displayed for 10 sec to allow the hardware low pass filter capacitors to charge up.

"busy" will then be displayed for 15 sec while the 5.0 V calibration is attempted.

The error message "CALIBRATION ABORTED, CHANNEL x OUT OF RANGE +/- yyyyyy" will be displayed for one of the same reasons describd above. Press **ESC** to return to the menu, the original calibration will still be in effect.

"input calibration is complete" will be displayed if the 5.0 V calibration was successful. Press **ESC** to return to the menu, the new calibration will be in effect.

Repeat the above procedure for any other Boards that are going to be calibrated. Then COPY PRIMARY TO BACKUP (see pg 4-16), and then EXIT S/M (see pg 4-9).

Analog Output Calibration Procedure

This procedure requires a DC milliamp meter to measure the 4-20 mA output signal to within +/-0.002 mA. This means that the DC milliamp meter must display at least “5 ½ digits” (ie, 20.001). However, not all 5 ½ digit Voltmeters have +/-0.002 mA accuracy, depending on the accuracy specification of the meter, a 6 ½ digit meter may be required.

Most portable test meters and voltage calibrators have 4 ½ digits or less of display resolution. “Calibrating” the PCC III with a less than 5 ½ digit DC milliamp meter will result in lower PCC III accuracy.

This procedure applies to the CPU Board (Board 0), Option Board 1, and Option Board 2. While a group of Analog Inputs are calibrated all at the same time, each 4-20 mA Ouput must be calibrated individually. Using the CPU Board will be used as an example, the procedure is as follows:

ENTER S/M for ALL Outputs (see pg 4-9).

Remove all field wiring from the Analog Output channel to be calibrated. Alternatively, un-plug the field wiring connector, and plug-in a spare field wiring connector.

Wire the “+” terminal to the milliamp meter (see Section 2 for terminal numbers).

Wire the “-” terminal to the milliamp meter.

Scroll to BOARD x OUTPUT y , ("x" is the Board number, CPU=0; "y" is the channel on that board)

Press **ENTER,** "SET OUTPUT TO 4.00 MILLIAMPS, THEN PRESS ENTER" will be displayed.

The error message "MUST BE IN S/M TO CALIBRATE" will be displayed if ALL of the Outputs are NOT in S/M mode (see pg 4-9).

The error message "CALIBRATION ABORTED, DEVICE OUT OF COMPLIANCE" will be displayed if the actual current output is not aprroximately 4 mA. This can be caused by: milliamp loop is open circuit, the test meter is set to Volts instead of Amps, there is too much resistance in the loop, or an external voltage or current source is connected to the field wiring. Press **ESC** to return to the menu, the original calibration will still be in effect.

Using the **EDIT ▲** or **EDIT ▼** keys, and observing the milliamp meter, set the 4-20 mA Output to 4.000 mAdc,
+/-0.003. The number shown on the Numeric display is used by factory technicians for diagnostics.

Press **ENTER,** "SET OUTPUT TO 20.00 MILLIAMPS, THEN PRESS ENTER" will be displayed.

The error message "CALIBRATION ABORTED, …" can be displayed for the same reasons described above. Press **ESC** to return to the menu, the original calibration will still be in effect.

Using the **EDIT ▲** or **EDIT ▼** keys, and observing the milliamp meter, set the 4-20 mA Output to 20.000 mAdc,
+/-0.003.

Press **ENTER**

"output calibration complete" will be displayed if the calibration was successful. Press **ESC** to return to the menu, the new calibration will be in effect.

Repeat the above procedure for any other Ouput channels that are going to be calibrated. Then COPY PRIMARY TO BACKUP (see pg 4-16), and then EXIT S/M (see pg 4-9).

COM PORT Menu

This menu is used to setup the communications parameters port, select the communications mode, and to test the RS485 cabling system. All Communications setup data is stored in the non-volatile EEPROM Blockware memory.

COM PORT
ADDRESS
BAUD
PARITY
RTU/ASCII
+/- DATA
TIME OUT
TEST CABLE

WARNING

Data changes that are made during the use of the EDIT A BLOCK, CALIBRATE, and COM PORT menu items are saved in the Primary memory; however, these changes are NOT saved in the Backup memory. To insure that a future "AutoLoad" (ie, copy Backup into Primary) loads these changes, the user must copy the Primary memory into the Backup memory using the MEMORY \ COPY PRIMARY TO BACKUP menu item (pg. 4-16). FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

COM PORT

The PCC III CPU board has two communications modes and connections:

RS485 at the rear terminal strip for Modbus Protocol Process Control Communications.
RS232 jack behind the Front Panel for Blockware Downloads, Uploads, and Diagnostics.

Modbus is an ANSI standard communications protocol that is used extensively for DCS, SCADA, and RTU applications. See Section 2 for wiring, Section 6 for **PLINK** Blockware interface, and "Modbus Functions" below for the supported Modbus functions.

The Download connection is designed specifically for use with either PC3_Edit or PC3_Draw Personal Computer based software. This software can be used for Blockware design, documentation, and diagnostics.

The CPU has one communications port (Com Port). The CPU Com Port can only be routed to one of the two connections at a time: Modbus (RS485), or Download (RS232).

Scroll to COM PORT, Press **ENTER.** "0=DOWNLOAD 1=MODBUS" will be displayed. Use the **EDIT ▲** or **EDIT ▼** key to choose either 0 or 1 on the Numeric display, Press **ENTER.** The display returns to the COM PORT menu.

ADDRESS

This item is ignored when COM PORT is set to DOWNLOAD.

This menu item determines the Modbus node address for this controller. The address can be any value from 1 to 32. The user must insure that each PCC III, or other Modbus devices on the same cable, have their own unique Address.

Scroll to ADDRESS, Press **ENTER.** Use the **EDIT ▲** or **EDIT ▼** key to set the Address on the Numeric display, Press **ENTER.** The display returns to the COM PORT menu.

BAUD

This menu item determines the Baud rate for both Modbus and Download modes. Available Baud rates are: 1.2k (i.e. 1200), 2.4k, 4.8k, 9.6k, 19.2 k, and 38.4k.

Scroll to BAUD, Press **ENTER.** Use the **EDIT ▲** or **EDIT ▼** key to set the Baud Rate on the Numeric display, Press **ENTER.** The display returns to the COM PORT menu.

PARITY

This menu item determines the parity for both Modbus and Download modes. ODD or EVEN Parity is available. PCC III does not support "No Parity".

Scroll to PARITY, Press **ENTER.** "PARITY ODD=1 EVEN=2" will be displayed. Use the **EDIT ▲** or **EDIT ▼** key to choose either 1 or 2 on the Numeric display, Press **ENTER.** The display returns to the COM PORT menu.

RTU/ASCII

This item is ignored when COM PORT is set to DOWNLOAD.

This menu item selects either Modbus RTU protocol, or Modbus ASCII protocol.

Scroll to RTU/ASCII, Press **ENTER.** "RTU=0 ASCII=1" will be displayed. Use the **EDIT ▲** or **EDIT ▼** key to choose either 0 or 1 on the Numeric display, Press **ENTER.** The display returns to the COM PORT menu.

+/- DATA

This item is ignored when COM PORT is set to DOWNLOAD.

This menu item directs the PCC III Modbus software to reply with either positive integers only, or signed integers (positive and negative). Some SCADA and DCS I/O driver software do not support signed integers. PCC III Block Outputs can range from –32700 to +32700. Set this parameter to UNSIGNED unless the SCADA or DCS system specifically supports signed integers.

Scroll to +/- DATA, Press **ENTER.** "SIGNED=0 UNSIGNED=1" will be displayed. Use the **EDIT ▲** or **EDIT ▼** key to choose either 0 or 1 on the Numeric display, Press **ENTER.** The display returns to the COM PORT menu.

TIME OUT

This item is ignored when COM PORT is set to DOWNLOAD.

When a valid Modbus message that is addressed to this node Address is received, the Communications status is set to Normal, and the Time Out timer is started. The Time Out timer is reset and restarted every time a new valid Modbus message is received. If PCC III stops receiving Modbus messages, the Time Out timer will expire, and the communications status will change to Failed. The Time Out can be from 1 to 120 seconds

Scroll to +/- TIME OUT, Press **ENTER.** Use the **EDIT ▲** or **EDIT ▼** key to set the desired seconds on the Numeric display, Press **ENTER.** The display returns to the COM PORT menu.

TEST CABLE

This item is ignored when COM PORT is set to DOWNLOAD.

This item tests the RS485 Modbus communications network. The PCC III sends an individual Loopback Test message to each of the 32 possible node addresses, and displays the node address of each device that sends back a normal reply. This test will verify the proper operation of the cabling system and the proper operation of each Modbus node.

Before starting the Cable Test:

- Turn off any software drivers that continuously poll the cable, such as SCADA or DCS workstations.
- Make sure that all nodes are set to the same Baud, Parity, and RTU/ASCII mode.
- Make sure that each device is set to a unique Address.
- Make sure that the COM PORT is set to MODBUS.

Scroll to TEST CABLE, Press **ENTER**, the Numeric display will start counting down from 5 to 1, and "testing" will be displayed. If no other nodes are polling the cable, the display changes to "scanning", and the Numeric display shows the address currently being tested.

If the addressed node does not reply, the address increments and the next node is tested.

If a node replies properly, the display changes to "found". The address of the node will be on the Numeric display, and the address scanning sequence stops. Press **ENTER** to resume the scanning for the remainder of the nodes.

Press **ESC** during the scanning to end the test, or Press **ESC** after that scan sequence has completed to return to the menu.

If a node fails to communicate, check all of the requirements in "Before starting the Cable Test" above, and then check the wiring for reversed polarity.

SUPPORTED MODBUS FUNCTIONS

The PCC-III includes both Modbus ASCII and RTU protocols, and supports the following Modbus Functions:

Function	Modbus Description	PCC-III Description	Notes
01	Read Coil Status	Read Discrete Block Output	
03	Read Holding Registers	Read Analog Block Output	
05	Force Single Coil	Write Single Discrete Block Output	1
06	Preset Single Register	Write Single Analog Block Output	2
08-00	Loopback Diagnostic		3
15	Force Multiple Coils	Write Multiple Discrete Block Output	1
16	Preset Multiple Registers	Write Multiple Analog Block Output	2

Notes:

1. Only RDIN and PB Blocks may be written to.
2. Only RAIN, FPT/H, FPCON Blocks and PLINK mapped Parameters may be written to.
3. Only the Loopback diagnostic subfunction (Code 00) is supported.

Addressing:

Each PCC-III is field configurable, therefore, the User must have the PCC-III Blockware Documentation or Drawing for the particular Controller that is going to be queried in order to know which Function Types are in which Blocks, and to know the significance of each signal.

The Controller Station Address is within the range 1-32 as described above.

Coil (ie, Discrete Block) addresses are simply the PCC-III Block Number. Example: Block 27 is a PB Block, Use coil address 00027 to read or write to the PB Block.

Holding Register (ie, Analog Block) addresses: 40xxx for Analog Block Outputs, and 41xxx for PLINK Parameters (See F124 in Section 6). For Analog Block Outputs, Use:(40000 + the PCC-III Block Number). Example: Block 6 is an AIN Block, Use address 40006 to read the AIN Block Output data. For PLINK Parameters, Use 41001-41030.

Note that some Modbus I/O driver software uses the 4000 series addresses when emulating smaller Modbus PLC's, and 400000 when emulating larger Modbus PLC's. Consult your I/O driver documentation to determine if 4000, 40000, or 400000 series addresses should be used.

A Poll group can be set up to query multiple coils or registers for a range of addresses that includes a mixture of Analog and Discrete Blocks. The only condition is that the first address of the Group must be the correct Analog or Discrete data type. The User should simply ignore the data from the addresses for invalid data types.

Example: The User wants to use one Modbus Multiple Register Read instead of several Modbus Single Register Read's to minimize Modbus Communication traffic. If B4 is AIN, B5 is DIN, B6 is AIN, B7 is DIN, ... If the User wants to read the first two analog points, then read addresses 40004-40006, but ignore the data returned for 40005. If the User wants to read the first two discrete points, then read addresses 40005-40007, but ignore the data returned for 40006.

Data Formats:

Coils (ie, Discrete Output Blocks): 0 = 0, 1 = 1.

40xxx Registers (ie, Analog Output Blocks): PCC-III 100.00% = Modbus 10000, PCC-III 0.00% = Modbus 0 in a 16 bit signed integer format. Most PCC-III Block Outputs are NOT limited to the 0.00% – 100.00% range and can use all or part of the full PCC-III +/- 327.00% range. Since the scaling of each signal is Blockware dependent, the User must consult the PCC-III Blockware to determine the engineering units.

41xxx Registers (ie, PLINK mapped Block Parameters): See F124 in Section 6 for Data Format Information.

Modbus Write Enable, Local/Remote Mode:

Modbus Writes are only enabled for PCC-III functions FPCON, FPT/H, and PB when the PCC-III is in Remote Mode. However, Modbus may write data to PCC-III functions RAIN and RDIN at any time.

The Remote/Local Mode input of either F123 COMM or F124 PLINK determines the PCC-III Remote/Local Status. Typically this input is linked to a PCC-III Front Panel Pushbutton labeled Remote/Local, or to an external physical switch. Consult the PCC-III Blockware for each controller to determine how the Remote/Local Status is controlled.

Section 5 – CONFIGURING BLOCKWARE

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Blockware Basics

PCC-III uses "Blockware" to implement the control strategies that are contained in the memory of the PCC III. The word "Blockware" is derived from the words Block diagram and software. The use of "Blockware" results in a clearly documented, easy to understand, and easy to configure a system. The basic elements of "Blockware" are as follows:

Blocks

The PCC III memory has 160 Blocks. Each Block is a container that a Blockware Function is put into. Think of a Block as a "cell" in an Excel or Lotus 1-2-3 spreadsheet, you put a formula or a function into a cell, and the formula uses the values from other cells as "Inputs" for the formulas. Another analogy would be physical relay sockets that have signal processing modules plugged into each socket (ie, Block). The controller includes sufficient memory to handle 160 Blocks (See figure 5.1).

Library of Functions

The PCC-III has an extensive library of Functions to handle any type of control task. These Functions are identified and described in detail in Section 6 of this manual. The library includes Functions for the conversion of Inputs to engineering values, mathematical operations, logical operations, timing operations, the traditional PID algorithm as well as other types of special **PID** Functions. Additional special Functions such as "Learn", "Boiler Efficiency", etc. are also included and are described in depth in Section 6.

Any-Function-Any-Block

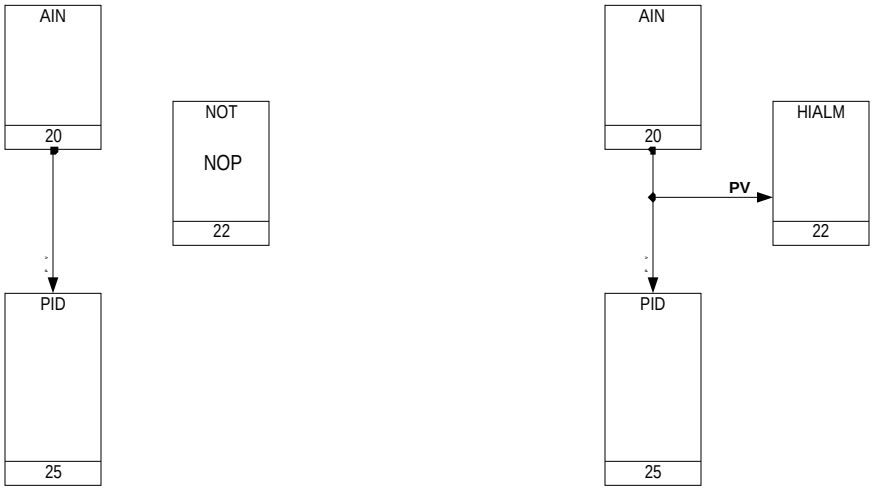
Each Block is assigned a "Function type" during configuration. Any "Function type" can be used in any Block number. The "Block number" only determines the order in which the Blocks are calculated. In the example below at left, Block number 22 is not being used, so it has the default **NOP**, or "**N**o **OP**eration" Function in it. At Right , Block 22 was changed from a **NOP** to a **HIALM** (high alarm) Function type.

Reusable Functions

Almost all PCC III "Function types" can be used as many times as required, within the 160 Block limit. There are some Functions that are directly linked to the hardware that can only be used as many times as there is mating hardware. For example, only one **PANEL** Function (Front Panel Display Interface) can be used because there is only one Front Panel. While those related to **PID** Functions, curve fitting Functions, etc. can be used as many times as is deemed necessary for the application.

Softwiring

Most Function Types, like **HIALM,** need information from other sources (ie, Blocks) in order to calculate a result. Softwiring is the term used to describe how the Blocks are interconnected within the software. Softwiring allows the Input of a Block to monitor the Output of any other Block. At right below, the PV (Process Variable) Input of Block 22 (**HIALM**) is monitoring the Output of Block 20 (**AIN**), via a Softwiring connection.



PCC-III Blocks

A0 0% 0	A1 100% 1	D0 0 2	D1 1 3	NOP 4	NOP 5	NOP 6	NOP 7	NOP 8	NOP 9
NOP 10	NOP 11	NOP 12	NOP 13	NOP 14	NOP 15	NOP 16	NOP 17	NOP 18	NOP 19
NOP 20	NOP 21	NOP 22	NOP 23	NOP 24	NOP 25	NOP 26	NOP 27	NOP 28	NOP 29
NOP 30	NOP 31	NOP 32	NOP 33	NOP 34	NOP 35	NOP 36	NOP 37	NOP 38	NOP 39
NOP 40	NOP 41	NOP 42	NOP 43	NOP 44	NOP 45	NOP 46	NOP 47	NOP 48	NOP 49
NOP 50	NOP 51	NOP 52	NOP 53	NOP 54	NOP 55	NOP 56	NOP 57	NOP 58	NOP 59
NOP 60	NOP 61	NOP 62	NOP 63	NOP 64	NOP 65	NOP 66	NOP 67	NOP 68	NOP 69
NOP 70	NOP 71	NOP 72	NOP 73	NOP 74	NOP 75	NOP 76	NOP 77	NOP 78	NOP 79

Figure 5.1

Note: Blocks 0 through 3 are automatically configured by the firmware as Functions **AO, A100, D0,** and **D1**, as shown above. These four Blocks can not be changed to a different Function.

Block 0 (**A0**) is automatically Softwired to whenever the Function Type of a Block is changed. Block 2 (**D0**) is likewise Softwired to all Block Inputs that require an discrete value.

PCC-III Blocks (continued)

NOP 80	NOP 81	NOP 82	NOP 83	NOP 84	NOP 85	NOP 86	NOP 87	NOP 88	NOP 89
NOP 90	NOP 91	NOP 92	NOP 93	NOP 94	NOP 95	NOP 96	NOP 97	NOP 98	NOP 99
NOP 100	NOP 101	NOP 102	NOP 103	NOP 104	NOP 105	NOP 106	NOP 107	NOP 108	NOP 109
NOP 110	NOP 111	NOP 112	NOP 113	NOP 114	NOP 115	NOP 116	NOP 117	NOP 118	NOP 119
NOP 120	NOP 121	NOP 122	NOP 123	NOP 124	NOP 125	NOP 126	NOP 127	NOP 128	NOP 129
NOP 130	NOP 131	NOP 132	NOP 133	NOP 134	NOP 135	NOP 136	NOP 137	NOP 138	NOP 139
NOP 140	NOP 141	NOP 142	NOP 143	NOP 144	NOP 145	NOP 146	NOP 147	NOP 148	NOP 149
NOP 150	NOP 151	NOP 152	NOP 153	NOP 154	NOP 155	NOP 156	NOP 157	NOP 158	NOP 159

Figure 5.1 (continued)

PCC-III Terminology / Glossary

Block
The memory of the PCC-III is divided into 160 groups. Each group or "Block" can be set-up by the user to perform a specific task, such as: (A*B), (A+B), square root, PID control, etc. The task that a Block performs is determined by the "Function type" that we assign to the Block. "Function type" is explained below. NOTE: Blocks are often referred to as "B1", "BLK 1", or simply by the Block's number.

All Blocks are identified by a number (0 thru 159). This number determines the sequence in which the Block tasks are carried out. PCC-III computes each Block in sequence from 0 thru 159, and computes all 160 Blocks 10 times per second. All 160 Blocks are always present; those Blocks which are not in use are simply assigned a "No Operation" (**NOP**) Function type.

Blockware Configuration
This refers to the process of entering information into the Blocks; such as: the "Function type" (ie, the task that each Block will perform), the specification of which of the 4 field Inputs a particular Block will use, the gain of a specific PID control Function, etc. A controller's configuration, as a whole, determines how the overall controller will function. Multiple PCC-IIIs can be equipped with identical hardware (circuit boards, etc.), but each can be configured to Function completely differently.

Function Type Or Function Code Number
The Function Code Number is a number that identifies the type of computation or the type of action that a Block will perform. Examples are:

2	get an analog Input from the field terminal strip
51	calculate (A*B) / C
71	calculate a PID controller Output
118	x seconds after Input turns on, turn on Output

Numbers are hard to remember, so normally we refer to each of the Functions by using an abbreviation (or Function Name), such as:

2	AIN	**A**nalog **IN**put
51	AB/C	(**A*****B**) / **C**
71	PID	**PID** controller
118	DAETDR	**D**elay **A**fter **E**nergize **T**ime **D**elay **R**elay

When setting up a PCC-III you must enter the "Function Code Number". All of the Functions available in the PCC-III are listed in numerical order in Section 6 (Blockware Technical Reference) of the instruction manual, and the task that each type performs is described in detail as well. Section 6 provides two Table of Contents: the first is in Function Code Number order, the second is in Function Name order.

Input
There are two types of inputs: electrical signals that are physically wired to the rear terminal strip of the controller, and imaginary connections inside the PCC-III that "Softwire" a signal from the Output of one Block to the Input of another Block. Normally, when we talk about "Inputs" we will be talking about the "Softwire" connections internal to the PCC-III.

Every Block produces a single Output. The Function type determines the Output value. Some Functions do not require any Input from any other Blocks… for example: the AIN Block receives it's 0-5 Vdc input from the PCC-III's field terminal strip… while other Functions require multiple Inputs… for example: the AB/C Block requires that three values be inputted (A, B, & C).

Inputs can be referred to by a meaningful abbreviation such as "A", or "PV" (**P**rocess **V**ariable), or by an Input number (I1, I2, etc.). Section 6 describes the purpose of each Input for each Function type. Note: The Input value for one Block is always the Output value of some other Block.

Parameter
Many Functions require setup information to work properly. We call these values parameters. A parameter can be used to make a selection such as: do you want to take the square root of this field? 1 = yes, 0 = no. The reset rate of a PID Function would be considered a parameter. The setpoint of a high alarm would be a parameter.

Basically any value that needs to be established when the controller is first configured or those values that the user will change rarely are considered to be parameters. Later in this section the purpose of each Function's parameter will be identified in detail. Parameters are referred to by their name or by "P1", "P2", etc.

Analog
Block Outputs within the PCC-III that can be varied continuously and in small increments are called "analog" values. A 4-20 ma or 3-15 psi field signal are examples of external analog signals.

Analog values inside the PCC-III are normally considered to be 0.00%-100.00% values. However, Block Outputs can actually range from –327.67% to + 327.67%, and all computations are carried out to 0.001% internal resolution.

Discrete
Block Outputs within the PCC-III that can only have values of 0 or 1 (i.e. ON/ OFF, HI / LOW) are called "discrete" values. Discrete and analog values cannot be intermixed. That is, if a particular Function type calls for one of it's Inputs to be an analog value, then the user cannot assign a Block with a discrete Output to this Input.

ROM
ROM stands for **R**ead **O**nly **M**emory. ROM memory is the non-volatile, permanent memory that stores all the firmware (ie, non changeable software) that makes the PCC-III work. This memory is not lost when the power is turned off. The user can not modify the ROM firmware. The PCC-III Function types, menu editor, Modbus protocol, front panel, version number, etc. are stored in ROM.

RAM
RAM stands for **R**andom **A**ccess **M**emory. RAM can be read from and written to. RAM is volatile, temporary, memory that is erased every time power is lost. RAM is where the configuration Blockware is processed.

EEPROM
EEPROM stands for **E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory. The PCC-III has one Primary and one backup EEPROM chip. The Primary EEPROM is soldered to the board. The backup EEPROM is in a removable socket.

Upon power-up the PCC-III copies the contents of the Primary EEPROM to RAM. The controller then operates from this RAM. When the user makes a configuration change, he/she is writing to RAM. The PCC-III automatically copies RAM to the Primary EEPROM after leaving EDIT mode if any changes are made to RAM. Thus, any change the user makes to the program is saved in the non-volatile Primary EEPROM.

Using the MEMORY menu in EDIT, the user may copy Primary EEPROM into the backup EEPROM. All Microprocessors are susceptible to severe electrical noise. Though the PCC-III is well protected, it is possible for the contents of memory to be lost or scrambled. If this happens, the PCC-III will Autoload the contents of the backup EEPROM to the Primary EEPROM and RAM and the system will continue to operate, see Section 4.

Retentive Memory
Retentive memory is a special area of the EEPROM used to automatically save and restore specific Block Output values at power-down and power-up. Typically, Setpoints, Ratios, flow totals, and pushbutton status's are saved and restored to/from Retentive Memory. Retentive Memory allows a controller to resume controlling in the same state following power up as it was prior to shutdown.

The Block Output values of the following Function Types are saved to and restored from Retentive Memory: FPT/H (Front Panel Track and Hold), F(T) (Function of Time ramp generator), FPCON (Front Panel Constant), COUNT (Pulse Counter), RDIN (Remote Discrete Input), PB (Pushbutton), and F/F (Flip/Flop). All other Function Type Outputs are re-calculated every scan based on the current Inputs, and are not restored at power up.

Note: All Block Parameters and Input Softwiring data of all Function Types are always saved in EEPROM.

As extra insurance, The PCC-III also automatically updates Retentive memory whenever any Retentive Block Output value changes during normal operation (not to exceed once every 10 minutes).

Each PCC-III provides 56 bytes of Retentive memory, which is sufficient most complex control strategies. Section 6 details how many bytes each Retentive Function utilizes. EDIT will not allow you to use more memory than is available, and will display an error message.

EEPROM memory is conservatively limited to 95,000 individual byte updates before potentially losing data. EEPROM's will retain data for approximately 100 years when powered down. PCC-III provides 6 Retentive memory areas with auto-selection based on usage. Therefore, PCC-III Retentive memory is limited to 570,000 updates. If updated continuously at once per 10 minutes, the Primary EEPROM will have to be replaced after 10.8 years. If Retentive Memory is only saving infrequently updated Blockware, the Retentive memory will probably never have to be replaced.

The EDIT / MEMORY / REMAINING MEMORY REPORT menu (ROM 2.23 or 3.01 or higher) can be used to view the REMAINING MEMORY WRITES. At power-up, PCC-III will not leave Service Manual mode if the REMAINING MEMORY WRITES equals zero, and an error message will be displayed.

Configuring Blockware Control Logic

In many applications the PCC-III Blockware is pre-configured at the factory. In some cases, it is desirable to modify that configuration in the field. In other cases the customer may want to add features due to process changes. Yet in other cases, the customer may have a preference for configuring their own system.

The PCC-III allows for easy modification or complete development of a configuration in the field. The PCC-III can be completely configured using the front panel EDIT keys along with the digital and alphanumeric displays. The configuration is handled via easy to follow menus that are controlled by four keys on the flip-down door on front panel. A Password system can be enabled to prevent unauthorized use. The configuration keys allow modification of All PCC III data in the field without the use of any other devices such as special hand-held configurators or laptop computers.

Note: The CPU board includes an RS232 port to allow a Personal Computer (ie, PC) to be used as a configuration tool. The PC also allows the downloading and retrieval of stored configurations along with the ability to fully document the configuration. Preferred Instruments PC3_Edit or PC3_Draw software is required to upload or download Blockware data via the RS232 port.

Development of good control strategy starts with a well conceived game plan. These few steps will help the user to configure the PCC-III in a timely manner:

- Define the user's requirements
- Check the system Input/Output (I/O) count
- Break the configuration down into manageable sections
- Sketch each section
- Assign (ie, change) the Function Types in each Block
- "Softwire" the Block Inputs
- Modify Parameters as required
- Configure the front panel displays and alarms
- Test the configuration
- Place controller into operation

The remainder of this Section will be a detailed example of how to enhance a simple Boiler Master Blockware Control Strategy by adding features in small manageable sections.

Modifying a “Boiler Master” Blockware Configuration

Let’s suppose a customer has developed a simple “Boiler Master” configuration as shown in Figure 5.2. The configuration consists of a steam drum pressure transmitter Input, drum pressure setpoint, a PID control loop, a 4-20 ma “firing rate demand” Output wired to a control actuator or valve, logic to send the Output to “low fire” (via a discrete Input from the Flame Safeguard System (FSG) and Auto/Manual control logic. The customer has decided to add an Input from a Plant Master controller and add high and low boiler drum pressure alarms.

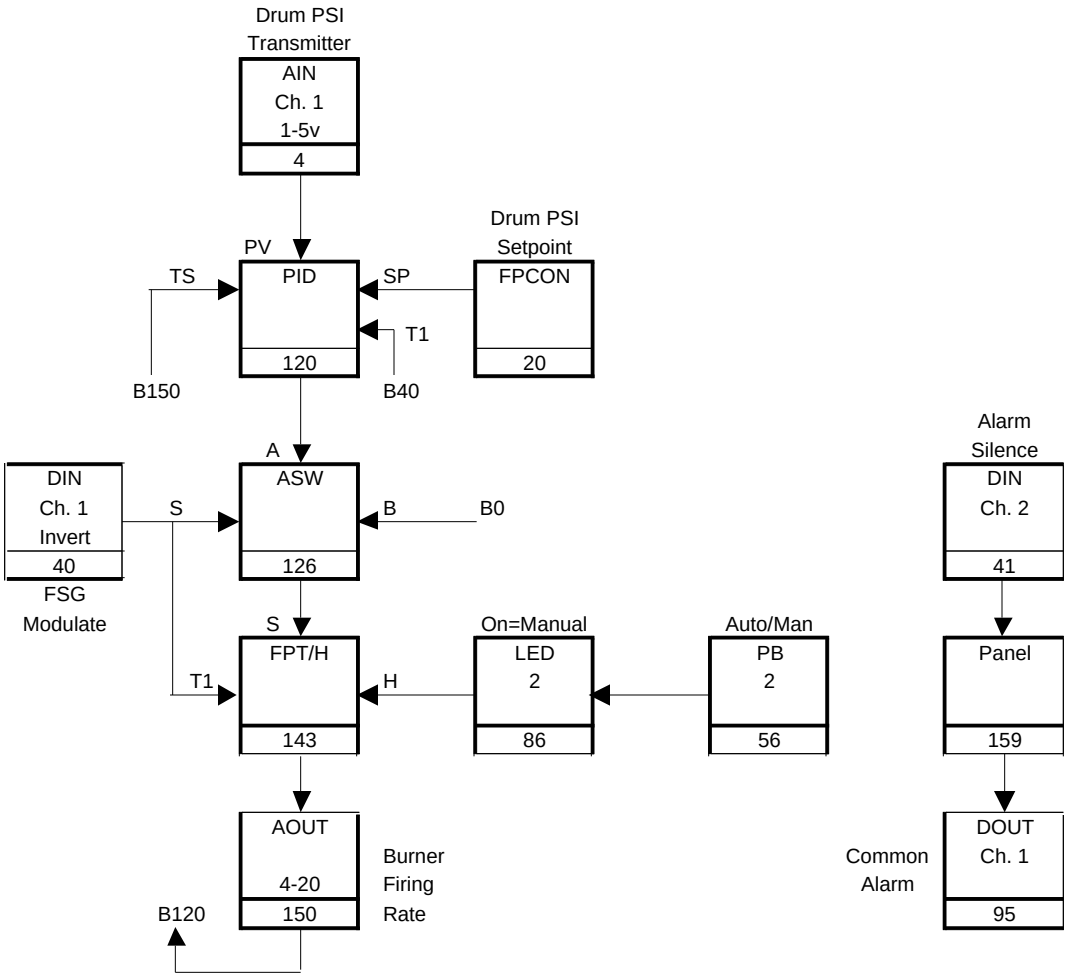


Figure 5.2

Following the recommended approach:

Define the requirements.

We will need to add an input for the Plant Master Demand, a Submaster bias station (to load balance the boilers), a pushbutton to switch between Plant Master or Local PID control, an LED to show the user which of these modes the controller is in, and high and low pressure alarms. The front panel display must also be modified.

Check the I/O count

The controller has four extra inputs available. If the user wants the Plant Master input to be electrically “isolated”, an option card will be required. Isolating the Plant Master is not required, but it is a more robust system design that prevents a single wiring problem from affecting multiple boilers.

Break the configuration down into manageable sections

This is a relatively small change. We will add an alarm section, a Submaster bias section and a control mode section.

Sketch each section

Figure 5.3 (below) highlights each section that is to be added to the original configuration. The Plant Master section will require an input Block (AIN), a Front Panel Constant Block (FPCON) for the Submaster bias, and a weighted sum Block (WSUM) to calculate the bias. The Plant Master / Local PID selector requires a pushbutton Block (PB), an indicator Block (LED) and a switching Block (ASW). The alarm section requires a high alarm Block (HIALM) and a low alarm Block (LOALM).

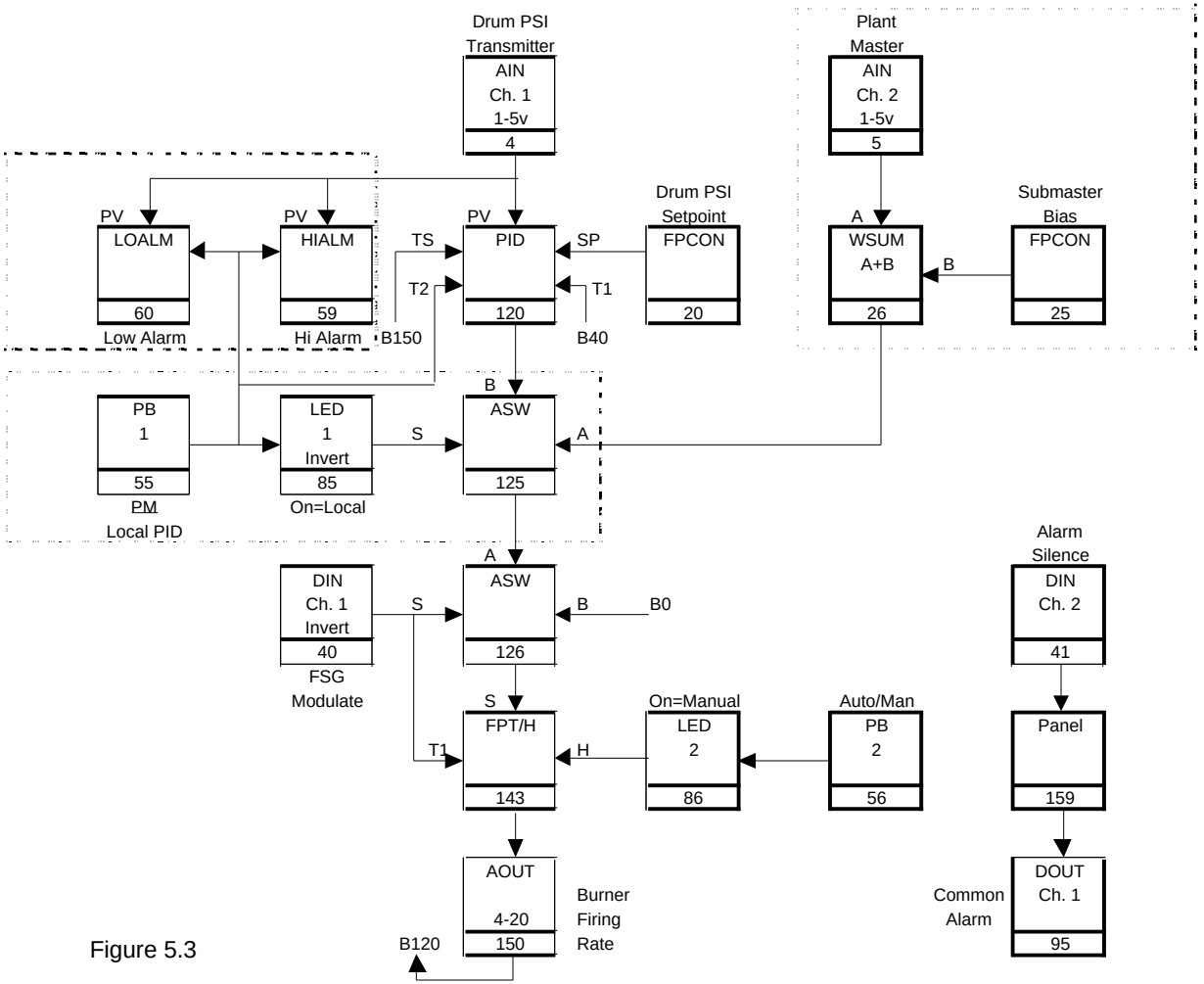


Figure 5.3

Please read Section 4, which explains how to use the PCC-III EDIT menus. You must know how to modify a Block as well as how to copy the Primary Blockware memory to the Backup memory before proceeding.

Change the Function Type of a Block

Change Block 5 from a **NOP** to an **AIN** Function Type

- Put the PCC-III in the **EDIT** mode.
- **EDIT** t until you see "ENTER S/M" in the bottom (alpha-numeric) display, then press **ENTER** two (2) times. This puts all the Outputs into the "Service Manual" mode.
- **Note:** the PCC-III requires that the controller be in "Service Manual" for some calibration and configuration tasks. When configuring on-line while in "Service Manual", you do not have to worry about the process jumping up or down during configuration. However, the process may need to be adjusted while in this manual condition.
- **EDIT** t to "EDIT A BLOCK". Press **ENTER**. The previous Block edited is displayed in the top (numeric) display.
- **EDIT** s or t until (Block) "5" appears on the numeric display. Press **ENTER**. The Alphanumeric LED should be flashing and the display will read "B05 NOP". The numeric display should read (Function) "127".
- Press **ENTER** to access the numeric display (top LED will flash). **EDIT** t until you reach Function 2. Lower display will read "B05 AIN". Press **ENTER**. Refer to Section 6 and look at Function 2 (**AIN**).

"Softwire" the Block Inputs

This particular Function type, **AIN**, does not have any Blockware Inputs; therefore, no Softwiring is required. See "Block 26" below for the first example of Softwiring an Input.

Modify Parameters as required

There are seven parameters that can be configured. In many cases the default value that was loaded by EDIT will be used. However, some parameters need to be modified to suit the needs of the desired Control Strategy.

- **EDIT** t to Parameter 1 (P01). This tells the PCC-III what board the Input resides on. We are using **AIN** ch. 2 on the CPU board. Thus, P01 should be left as "0".
- **EDIT** t to P02. The Plant Master input will be directed to **AIN** ch. 2. Press **ENTER** to access the numeric display. **EDIT** up until "2" is displayed. Press **ENTER** again.
- **EDIT** t to P03. The numeric display should read "1.000"… when the input from the Plant Master is 0%, there will be a 4 ma signal dropped across a 250-ohm resistor, creating a 1.000 volt drop across the input.
- **EDIT** t to P04. The top display should read "5.000"… when the input from the Plant Master is 100%, there will be a 20 ma signal dropped across a 250 ohm resistor, creating a 5.000 volt drop across the input.
- **EDIT** t to P05. The top display should read "0". We will not need to square root this input.
- **EDIT** t to P06. The top display should read "1.0". This represents a 1 second filter for the input which should help to eliminate noise or sharp spikes.
- **EDIT** t to P07. The top display should read "0.00". This corresponds to a "low flow cut-off" limit which is not required for this application.
- Press **EDIT (ESC).** (Block) "5" should reappear on the numeric display.

Block 25, **FPCON**

We need a Front Panel Constant to adjust/display our Submaster Bias. We will setup a +/- 50% bias adjustment range.

- **EDIT** s to Block 25. Press **ENTER**.
- Using the skills you developed above in Block 5, make Block 25 a **FPCON** Block (Function 55). Refer to Section 6 for details on the purpose of each Input and Parameter. There are two parameters to setup.
- Configure P01 as -50.00 (min output)
- Configure P02 as 50.00 (max output)

Block 26, **WSUM**

We want to apply the positive or negative Submaster Bias to the Plant Master signal. We will setup the **WSUM** (Function 52) as "A + B" with Input A as the Plant Master signal and Input B as the +/- Bias signal.

- **EDIT** s to Block 26. Press **ENTER**.
- Make Block 26 a **WSUM** Function (Function 52). There are three Inputs and 4 parameters to setup.
- Configure I01 (A) to be from B5.
- Configure I02 (B) to be from B25.
- Configure I03 (C) to be from B0 (no Input).
- Configure P01,2 & 3 as 1.00
- Configure P04 as 0.00.

Block 55, **PB**

We need to add a pushbutton to select Local PID or Plant Master control.

- **EDIT** s to Block 55. Press **ENTER**.
- Make Block 55 a **PB** Function (Function 98). There are three parameters to setup.
- Configure P01 as 1. This is the top left pushbutton.
- Configure P02 as 3. This is a toggle button.
- Configure P03 as 3. We want the button to power up in its last mode of operation.

Block 59, **HIALM**

We will assume the Plant Master has a high and low header pressure alarm. We want high and low drum pressure alarms only when in Local PID mode.

- **EDIT** s to Block 59. Press **ENTER**.
- Make Block 59 a **HIALM** Function (Function 101). There are three Inputs and five parameters to setup.
- Configure I01 (PV) to be from B4.
- Configure I02 (External SP) to be from B0. We will use an internal setpoint.
- Configure I03 (Disable Input) to be from B55. We want no alarm if in the Plant Master mode.
- Configure P01 as 2. We want internal Setpoint mode.
- Configure P02 as 1.00. 1% of the Drum Pressure transmitter's full scale range gives us a deadband of 2 psig.
- Configure P03 as 70.00. 70% of the Drum Pressure transmitter's full scale range gives us a high alarm setpoint of 140 psig.
- Configure P04 as 1. Alarm is disabled when **PB**1 is high.
- Configure P05 as 60. We want a 60 second delay before the alarm sounds to prevent nuisance alarming.

Block 60, **LOALM**

- **EDIT** s to Block 60. Press **ENTER**.
- Make Block 60 a **LOALM** Function (Function 102). There are three Inputs and five parameters to setup.
- Configure I01 (PV) to be from B4.
- Configure I02 (External SP) to be from B0. We will use an internal setpoint.
- Configure I03 (Disable Input) to be from B55. We want no alarm if in the Plant Master mode.
- Configure P01 as 2. We want internal Setpoint mode.
- Configure P02 as 1.00. This gives us a deadband of 2 psig.
- Configure P03 as 40.00. This gives us a low alarm setpoint of 80 psig.
- Configure P04 as 1. Alarm is disabled when PB1 is high.
- Configure P05 as 60. Sixty second delay before the alarm sounds.

Block 85, **LED**

We need a light to tell us whether we have selected Local PID or Plant Master control. The pushbutton legend will be setup as "PM/Local PID". Thus, when the **LED** is on we are in Local PID control mode.

- **EDIT** s to Block 85. Press **ENTER.**
- Make Block 85 an **LED** Function (Function 99). There is one Input and two parameters to setup
- Configure I01 from B55.
- Configure P01 as 1. This is the top left LED.
- Configure P02 as 1. We need to invert the Input. When PB1 is low (0) the LED is "on" (Local PID).

Block 125, **ASW**

- **EDIT** s to Block 125. Press **ENTER**.
- Make Block 125 an **ASW** Function(Function 34). There are three Inputs and three parameters to setup.
- Configure I01 (A) to be from B26.
- Configure I02 (B) to be from B120.
- Configure I03 (Select) to be from B85. High (Local mode) selects Input B.
- Configure P01 as 1. We want transfer rate limiting to avoid any 'bumps' when switching modes.
- Configure P02 as 1.00. This gives us a 1% per second transfer rate going from Plant Master to Local PID mode.
- Configure P03 as 1.00. This gives us a 1% per second transfer rate going from Local PID to Plant Master mode.

Modify Block 120, **PID**

When adding or deleting Blocks, we must remember to review all of the existing Blocks to see if any their Inputs are affected.

- **EDIT** t to Block 120.
- Configure I07 (Track mode 2) to be from B55. This forces the **PID** Block Output to track the Firing Rate when in the Plant Master mode.

Modify Block 126, **ASW**

- **EDIT** s to Block 126.
- Configure I01 (A) to be from B125.

Configure the front panel displays and alarms

Modify Block 159, **PANEL**

This is the **PANEL** Block (Function 96). We must add display channels for the Plant Master Demand and Submaster Bias. We must also put the high and low drum pressure alarms in the annunciator. We will also change the bargraphs to display Plant Master Demand and Firing Rate demand when in the Plant Master mode.

- Configure I04 (Display Channel 4) to be from B5.
- Configure I05 (Display Channel 5) to be from B25.
- Configure I15 (PV Bargraph 2) to be from B5. Displays Plant Master Demand.
- Configure I16 (SP Bargraph 2) to be from B26. Displays Firing Rate demand. User can visually compare to Plant Demand bargraph and detect if there is any bias.
- Configure I17 (Output Bargraph 2) to be from B150. Displays Firing Rate.
- Configure I20 (Alarm Channel 1) to be from B59.
- Configure I21 (Alarm Channel 2) to be from B60.
- Check that I30 (Alarm Silence) is set to B41.
- Check that I31 (Annunciator Enable) is set to B3. This is always active.
- Configure P14 (Channel 4 decimal) to 0 (no decimal).
- Configure P15 (Channel 4 zero) to 0.
- Configure P16 (Channel 4 span) to 100. Plant Demand spans from 0-100%.
- Configure P17 (Channel 4 message) to read "Plant Demand". When you enter this parameter the first digit will flash. Use the **EDIT** s or **EDIT** t arrows until the proper letter/number/character is displayed. Press **DIS** button to advance to the next digit. Press **ENTER** when finished.
- Configure P18 (Channel 5 decimal) to 0.
- Configure P19 (Channel 5 zero) to 0. The Bias can go to –50%. This parameter must be set to what the value would be when B25 is at 0%. The PCC-III will plot a straight line passing through the zero and span settings.
- Configure P20 (Channel 5 span) to 100. The Bias can go to +50%. This parameter must be set to what the value would be when B25 is at 100% (even if it can never get there).
- Configure P21 (Channel 5 message) to read "BSM BIAS".
- Configure P42 (Channel 1 alarm message) to read "HIGH PSI".
- Configure P43 (Channel 2 alarm message) to read "LOW PSI".

Test the configuration

Read **Section 4** before testing. This section explains how to use the "Force" and "Examine" features of the PCC-III's Utility Menu. **The PCC-III should not be performing any control Function while being tested. Each Block that was added or was modified should be thoroughly checked prior to returning the PCC-III to process control**.

To test the configuration:

- Exit Service Manual (S/M). The PCC-III will perform several types of error checks. The controller will display any errors. The RUN light will become solid when all Outputs are out of S/M.
- Display "Plant Demand". Compare the numeric display to that of the Plant Master Output. If they do not match, check engineering units in B159 (PANEL) and check parameters of B5 (AIN).
- Display "BSM BIAS". Using the UP and DOWN arrows run the Bias all the way up and all the way down to verify the display ranges from -50% to +50%. Set the Bias to -10%. Using the PCC-III's Utility Menu, force the Plant Master Input (B5) to 50% or, if possible, base load the Plant Master at 50%. Examine B26. It should read 40%. If not, check the Inputs and parameters of Blocks 5, 25, and 26.
- Press the PM/LOCAL PID pushbutton on and off. The LED, PV and SP bargraphs should toggle accordingly. If not, check the Inputs and/or parameters of Blocks 55 (PB) & 85(LED). Place in Local PID mode.
- Place the controller in the Local PID mode. Force the Drum Pressure Input (B4) to 0%. Exit the **EDIT** mode. A "LOW ALARM" should annunciate. Acknowledge the alarm (press "ACK") and check the verbiage on the display. Correct if necessary. Note: A 4-20 ma simulator can be used as the Input in lieu of forcing the Block.
- Go back into the **EDIT** mode and force B4 to 100%. Exit the **EDIT** mode. A "HIGH ALARM" should annunciate. Acknowledge the alarm and check the verbiage on the display. Correct if necessary.
- Using the Utility Menu unforce all Blocks.
- Force the Output of B40 (DIN) to zero. This will allow you to adjust be analog Output. A '1' entered here would force the Output to 0%.
- Place the controller in Auto (Auto/Man light off). Select the Plant Master mode (PM/Local PID light off). Set the Bias to zero. Adjust the Plant Demand Input (B5) by using the Plant Master, a 4-20 ma simulator, or forcing the Block to a value. The Output of the controller (B150) should follow the Plant Master demand Input. The PV and SP bargraphs should be equal and should also follow the Plant Master demand. Add or subtract from the Plant Master demand by using the Bias. The Output should follow accordingly. The SP bargraph should be offset by the Bias value.
- Select the Local PID mode (PM/Local PID light on). Adjust the Drum Pressure Setpoint to a desired value. The SP Bargraph should follow accordingly (0-100% bargraph represents 0-200 psig). Using a 4-20 ma simulator (you may also force the Block to a value) adjust the Drum PSI Input (B4) above and below setpoint. The Output should react inversely. That is, as you go above setpoint, the Output will decrease and as you go below setpoint, the Output will increase. The PV bargraph should follow the Drum Pressure Input accordingly.

Place the controller into operation

If all the above tests were successful you are ready for operation. You should backup the configuration before doing so (See **Section 4**). Once in operation you should check the tuning (Gain, Integral, etc.) of the Drum Pressure PID control loop and adjust if necessary. **Note: it is good practice to place the controller and therefore the process in Manual before switching control modes**.

Add Pressure Compensated Steam Flow Blockware

Any type of control strategy can be configured in the PCC-III. Figure 5.4 is an example of a logic for pressure compensation of steam flow with subsequent totalization of that flow. Steam flow (and other compressible fluids) transmitters are subject to inaccuracies unless the inlet pressure is maintained constant. If the pressure fluctuates up or down, the indicated steam flow will be higher or lower due to changes in the steam's density. A steam density compensation strategy based on changes in steam pressure is depicted in Figure 5.4.

Block 37 compares the actual steam density (B36) to the design steam density (B35). Blocks 35 and 36 are Steam Density vs. Saturation Pressure curves. Inputs to B35 and B36 must be in a percentage of 1000 psig. Thus, if the orifice plate was designed for 100,000 lbs./hr at 100 psig, a value of 10% is entered into B34. Also,

if the drum pressure transmitter has a 0-200 psig span, a value of 20% is entered into B31. Block 32 converts the drum pressure transmitter (B4) to a value corresponding to "% of 1000 psig".

Steam flow is proportional to a constant times the square root of the delta-P (differential pressure) across the flow measuring element. Block 39 evaluates the square root of the steam density calculation. The Output of B39 is the compensated (corrected) steam flow. The corrected flow is sent to analog Output Block 151 (perhaps to a recorder) and to a totalizer (B42). If a value of 1000 cph (counts/hr) is entered into B42, each discrete Output (B96) pulse represents 100 lbs. of steam flow.

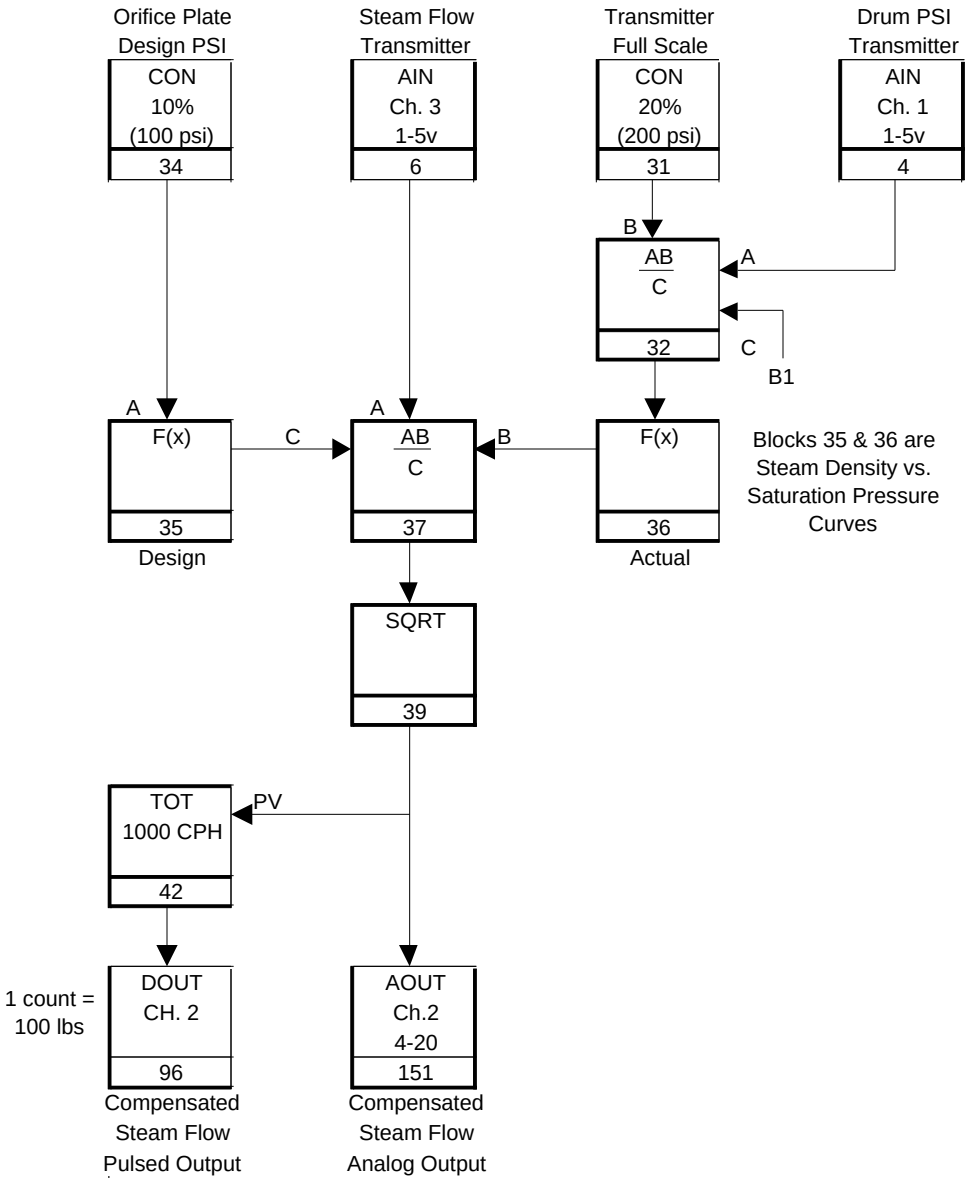


Figure 5.4

Add Purge and Light-off Positioning Blockware

Figure 5.5 is an example of the required Flame Safeguard System (FSG) interfaces for Boiler/Burner "Purge" and "Low-fire light-off" positions**. Note: there are cases when the "Low-fire light-off" firing rate is higher than the Burner's lowest attainable or minimum firing rate in operation**The logic we will develop will assure that there is sufficient fuel for Main Fuel Ignition while assuring that the full turndown capabilities of the burner are realized. This same logic is also applied to combustion air flow and draft control.

When the FSG is "off" (or the "Release to Modulate" Input B40 is not energized), the selected Input to B144 is high (1) which results in selection of the 'B' Input. When the FSG "Purge" contact (B42) is open, the firing rate Output is at the position determined by B30 ("Light-off" position constant). When the FSG calls for "Purge" (B42 closes), the firing rate demand is directed to 100% ("B" Input of B130), or that rate which meets the "Number of Air Changes" requirement recommended by NFPA. When the FSG establishes that the "Purge" period is complete, the firing rate is returned to the "Low-fire light-off" position (B42 opens). After Main Flame Ignition, the FSG will allow the control system to "Release to Modulate" (via closure of B40).

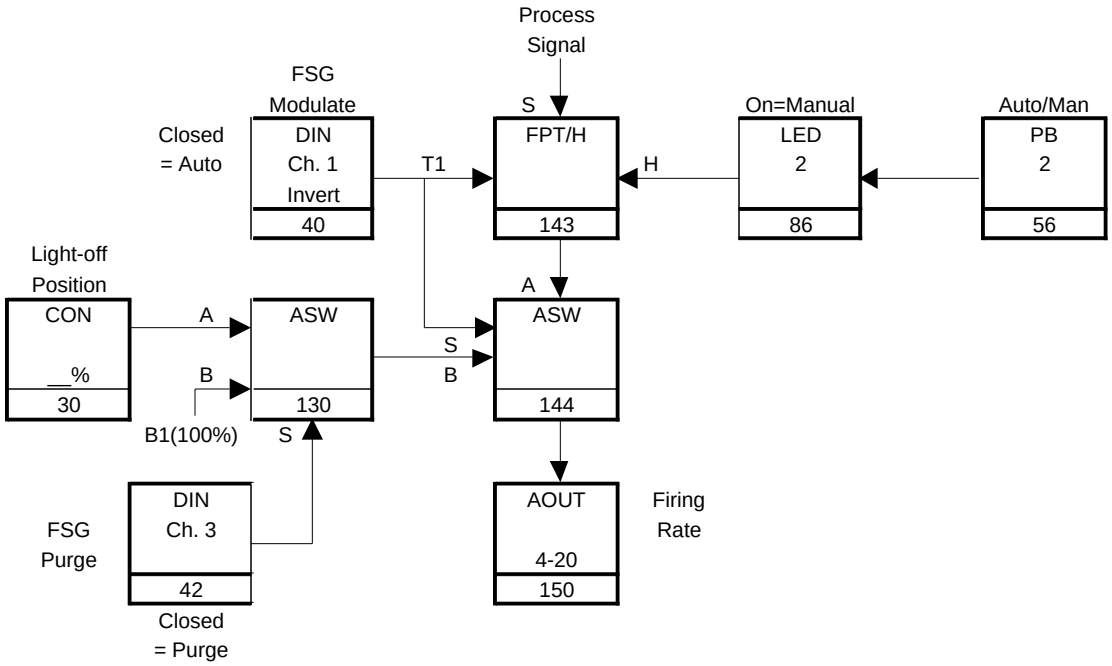


Figure 5.5

Add Day/Night Pressure Setpoint Blockware

Figure 5.6 is an example of a Day/Night Setpoint select circuit. Some facilities find it desirable to setback the steam pressure setpoint or hot water temperature setpoint at night to conserve fuel. This is accomplished by adding a few Function Blocks.

Pushbutton 3 (B57) and LED 3 (B87) are labeled Day/Night Setpoint. A discrete Input can be used in lieu of the pushbutton for remote setback. The control is in setback mode (Night Setpoint) when the LED is “on”. When the LED is “on” its Output is high (1). This selects the ‘B’ Input of B22 which is the Night Setpoint. Day and Night Setpoints can be adjusted from the front panel.

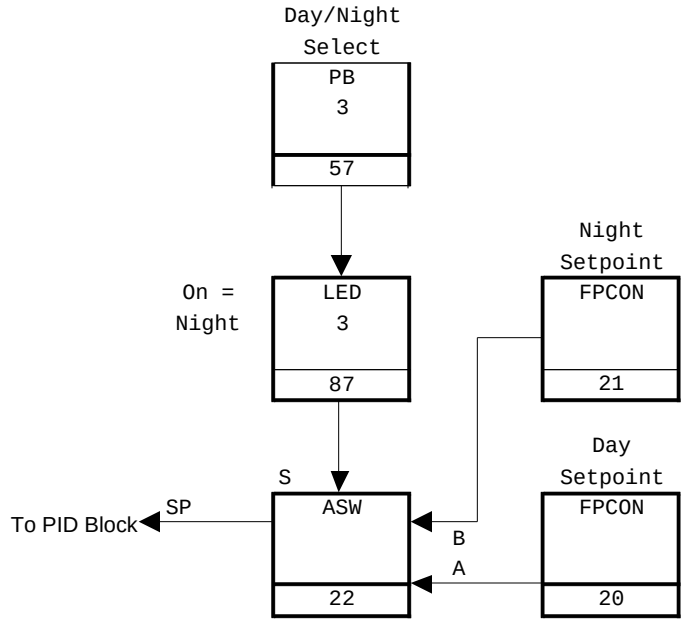


Figure 5.6

Revised Overall Boiler Master Blockware

Figure 5.7 (on the next page) shows how the individual control enhancements discussed in this section (figures 5.4, 5.5 & 5.6) can be incorporated into our original scheme (Figure 5.3) to produce a revised overall control strategy.

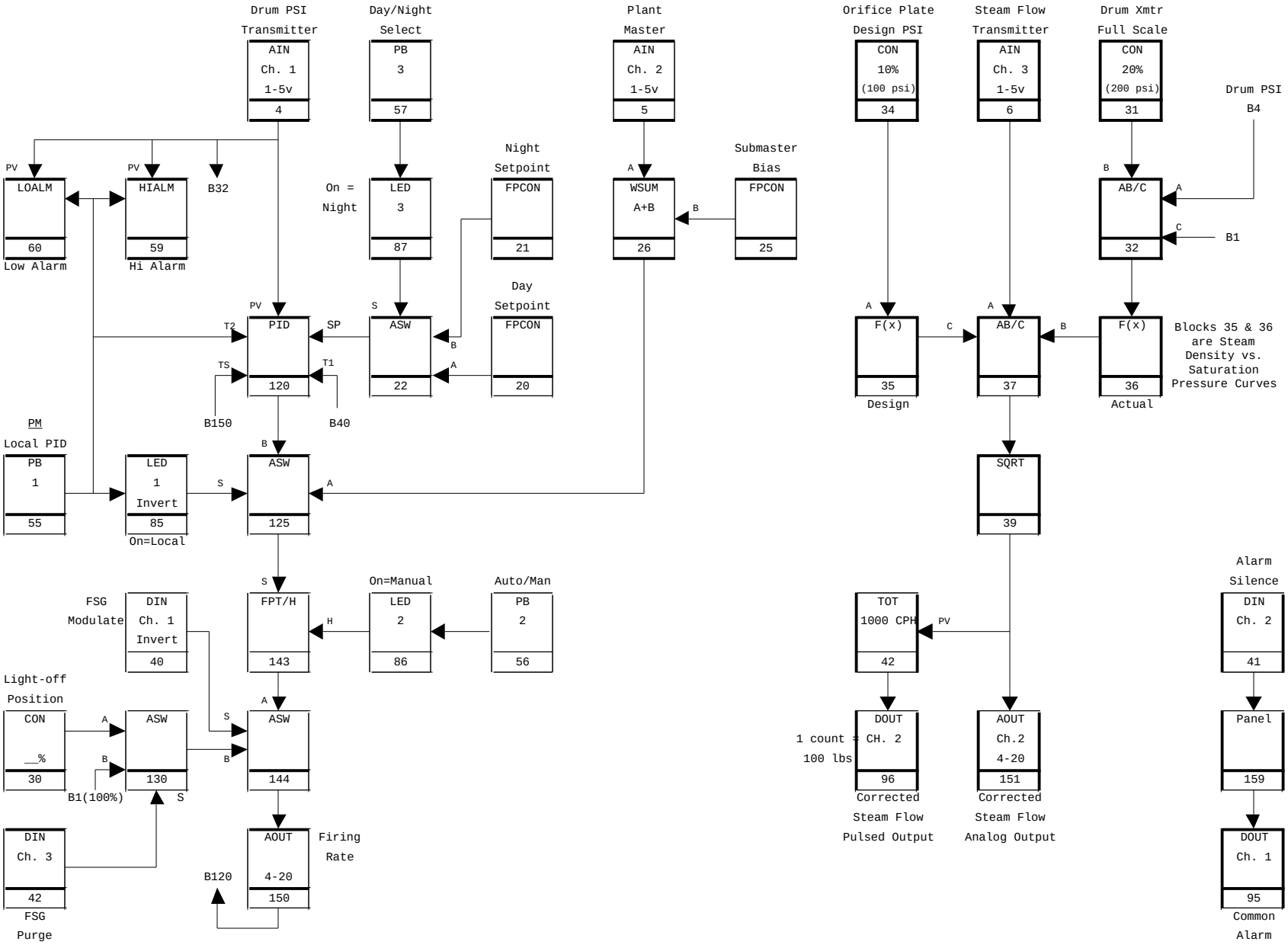

Drum PSI Transmitter
AIN Ch. 1 1-5v
4
Day/Night Select
PB 3
57
Plant Master
AIN Ch. 2 1-5v
5
Orifice Plate Design PSI
CON 10% (100 psi)
34
Steam Flow Transmitter
AIN Ch. 3 1-5v
6
Drum Xmtr Full Scale
CON 20% (200 psi)
31
Drum PSI
B4
PV
LOALM
60
Low Alarm
PV
HIALM
59
Hi Alarm
B32
On = Night
LED 3
87
Night Setpoint
FPCON
21
A
WSUM A+B
26
B
Submaster Bias
FPCON
25
B
AB/C
32
A
C
B1
PV
PID
120
S
ASW
22
Day Setpoint
FPCON
20
SP
T2
TS
T1
B150
B40
A
F(x)
35
Design
C
A
AB/C
37
B
F(x)
36
Actual
Blocks 35 & 36 are Steam Density vs. Saturation Pressure Curves
PM
Local PID
PB 1
55
LED 1 Invert
85
On=Local
S
B
ASW
125
A
SQRT
39
Alarm Silence
DIN Ch. 2
41
FSG Modulate
DIN Ch. 1 Invert
40
S
FPT/H
143
H
On=Manual
LED 2
86
Auto/Man
PB 2
56
TOT 1000 CPH
42
PV
Light-off Position
CON __%
30
A
ASW
130
B
B1(100%)
S
S
A
ASW
144
B
DOUT
1 count = 100 lbs
CH. 2
96
Corrected Steam Flow Pulsed Output
AOUT Ch.2 4-20
151
Corrected Steam Flow Analog Output
Panel
159
DIN Ch. 3
42
FSG Purge
AOUT 4-20
150
Firing Rate
B120
DOUT Ch. 1
95
Common Alarm

Figure 5.7

Section 6: Blockware Functions – Technical Reference

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F11	[DUAL] Dual Range Flow Transmitter Selector-Scaler	6
F20	[OPLR] Optical Path Length Ratio Correlation for Opacity Monitors	7
F22	[BEFF] Boiler Efficiency	7
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F32	[LSEL] Low Select	9
F33	[MSEL] Median Selector	9
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F36	[RLIM] Rate Limiter	10
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F43	[L/L] Lead – Lag with Gain (Dynamic Compensation)	18
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F52	[WSUM] Weighted Sum	21
F53	[INV] Invert	21
F54	[CON] Analog Constant	22
F55	[FPCON] Front Panel Adjustable Constant	22
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F58	[COUNT] Pulse Counter	23
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F60	[ABS] Absolute Value	24
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F92	[DIN] Discrete Input	35
F93	[DCON] Discrete Constant	35
F95	[S/M] Service Manual Status	35
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F97	[RDIN] (RS485) Remote Discrete Input	41
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Note: See the ZP Oxygen Analyzer Instruction Manual for Functions:
Functions ZAIN, AABO, and DABO are only included in ROM version 3.0 or higher.

F4	[AABO]	Analog Auxiliary Block Output
F6	[ZAIN]	ZP Oxygen Analyzer Analog Inputs
F94	[DABO]	Discrete Auxiliary Block Output

Functions TTRIP and TCODE are only included in ROM version 3.04 or higher.

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[A0]	Analog Constant, 0.00%	4
[A100]	Analog Constant, 100.00%	4
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[ABS]	Absolute Value	24
[AIN]	Analog Input	4
[AOUT]	Analog (4-20 mA) Output	28
[ASW]	Analog Switch	10
[BEFF]	Boiler Efficiency	7
[COMM]	RS485 Communications Link Control	55
[CON]	Analog Constant	22
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[DUAL]	Dual Range Flow Transmitter Selector-Scaler	6
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[F/F]	Flip Flop Logic	50
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[FPT/H]	Front Panel Adjustable Track / Hold	11
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Introduction

Section 6 provides detailed information on each of the Blockware Functions included in the PCC III firmware.

See Section 5 for details on designing and configuring Blockware control strategies.

Each Function has a Name and a Function Code Number, which are interchangable. The Function Name is a mnemonic, or abbreviation of the Function's description (Function Name "**AIN"** = Analog Input). The Function Code is the number that the PCC III internal firmware uses to reference a Function (Function Code "F2" = **AIN**). Typically, users refer to Functions by Function Name, not Function Code.

Functions are arranged in Function Code order in this Section.

Each Function has a verbal description, technical data (Header, Inputs, and Parameters), and when appropriate an application example. A glossary of the terminology used in the Technical Data area of each Function follows:

FUNCTION:	The Function Code Number
NAME:	The Function Name (ie mnemonic or abbreviation)
TEMP BYTES:	Bytes of "Temporary" RAM used per Block (1280 Bytes total are available)
RETENTIVE BYTES:	Bytes of "Retentive Memory" EEPROM used per Block (58 Bytes total are available)
DATA BYTES:	Bytes of "Data" EEPROM used per Block (5120 Bytes total are available)
SINGLE USE FUNCTION:	"N" = Function can be used in multiple Blocks "Y" = Function can only be used in one Block.
OUTPUT TYPE:	"A" = The Block Output is Analog: a –327.00 to + 327.00 % value. "D" = The Block Output is Discrete: a Logical "0" or Logical "1" value.
Input – Type:	"A" = The Block Output is Analog: a –327.00 to + 327.00 % value. "D" = The Block Output is Discrete: a Logical "0" or Logical "1" value.T
Parameter – Default:	The value assigned to this Parameter when a Function is initially assigned to a Block
Parameter – Max:	The maximum value that the Parameter can be changed to.
Parameter – Min:	The minimum value that the Parameter can be changed to.
Parameter – Code:	The minimum password level required to change a Parameter (if Passwords are enabled)

Default Block Inputs:
There are 160 "Blocks" in the PCC III (numbered 0 to 159). Think of a Block as a receptacle, or socket into which the user inserts a PCC III Blockware "Function". Any PCC III BlockWare "Function" can be inserted into any available Block.

Blocks 0 thru 3 are not avalibale to the user, and are permanently assigned the following Functions:

Block	Function	Comment
0	A0 (Analog 0%)	Default Analog Input
1	A100 (Analog 0%)	
2	D0 (Discrete "0")	Default Discrete Input
3	D1 (Discrete "1")	

When a Function is initially assigned to a Block, the Block Inputs are automatically connected to the Default Blocks as follows:

Block 0 (A0, or 0%) is connected to all of the Analog Inputs in the Block (if any).
Block 2 (D0, or Logic "0") is connected to all of the Discrete Inputs in the Block (if any).

F0 [A0] Analog Constant, 0.00%

Function **A0** provides a constant Output of 0.00%.

PCC III automatically configures Block 0 to be function **A0.** Block 0 (analog 0.00%) is the default Input for all analog Inputs for all functions. Block 0 cannot be changed to any other function. However, other Blocks may be configured as **A0.** No Inputs or parameters are required for **A0**.

```
-------------------------------------------------------------------------------------------
FUNCTION:  0            TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:   0
NAME:      A0                        SINGLE USE FUNCTION:   N        OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
No Inputs and No Parameters
```

F1 [A100] Analog Constant, 100.00%

Function **A100** provides a constant Output of 100.00%.

PCC III automatically configures Block 1 to be function **A100.** Block 1 (analog 100.00%) is useful as a dummy Input to many other functions: **ASW**, **AB/C**, … . Block 1 cannot be changed to any other function. However, other Blocks may be configured as **A100.** No Inputs or parameters are required for **A100**.

```
-------------------------------------------------------------------------------------------
FUNCTION:  1            TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:   0
NAME:      A100                      SINGLE USE FUNCTION:   N        OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
No Inputs and No Parameters
```

F2 [AIN] Analog Input

Function **AIN** is the Blockware interface to the PCC III Analog Inputs A/D converter hardware. **AIN** retrieves the 0.000 - 5.100 Vdc signal from the selected field terminals, applies a digital low pass filter, scales the voltage to a 0-100.00% Block Output, and optionally takes the square root. A jumper selectable 250 ohm, 0.1% resistor on the circuit board is used to convert a 4-20 mA Input to 1-5 Vdc Input. A hardware based low pass filter (-3db @ 0.6 Hz, -63 db @ 60 Hz) is included for each analog Input for noise reduction, and high frequency aliasing prevention.

The AIN function interfaces to Analog Inputs on the CPU board, and on option boards. Parameter 1 specifies the board location, the CPU board = board 0. Parameter 2 selects a particular Input on the specified board.

Any portion of the 0 - 5.100 Vdc Input range (0.5 Vdc min. span) may be selected and scaled to the 0-100.00% Block Output using parameters 3 & 4 . Voltages outside the configured 0-100.00% range produce proportional Block Outputs, within the limitations of 0-5.100 Vdc measurement range, and +/- 327% Block Output range. Parameters 3 & 4 may be configured for reverse Inputs (0% = 5 Vdc, 100% = 1 Vdc for 20-4 mA transmitters).

Scaling Example: Parameter 3 (0%) = 1.000 Vdc, Parameter 4 (100%) = 5.000 Vdc. Outputs for other voltages:
0.000 Vdc = -25%, 1.000 Vdc (or 4 mA) = 0 %, 4.000 Vdc (or 20 mA) = 75.00%, 5.100 Vdc in = 102.50%

The square root option is scaled for 0-100% Input = 0-100% Output, that is:
Block Output = 10 * [sq. root (Input).]

Square Root Example:
100% Input = 100% Output, 49% Input = 70% Output, 4% Input = 20% Output. Negative Inputs yield a 0% Output.

The Low Flow Cutoff parameter forces the Block Output to 0.00% if the Block Output would be less than (Parameter 7). This feature is bypassed if the Cutout is 0.0%.

```
-------------------------------------------------------------------------------------------
FUNCTION:  2          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:  40
NAME:      AIN                        SINGLE USE FUNCTION:   N        OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
No Inputs
```

Parameter	Description	Default	Max	Min	Code	Notes
1	OPTION BOARD (0=CPU BOARD)	0	2	0	3	
2	INPUT CHANNEL	1	5	1	3	1
3	VOLTS INPUT FOR 0% OUTPUT	1.000	5.100	0.000	2	2,3
4	VOLTS INPUT FOR 100% OUTPUT	5.000	5.100	0.000	2	2,3
5	SQ ROOT? 0=NO 1=YES	0	1	0	2	4
6	FILTER SECONDS	1.0	300.0	0.0	1	
7	LOW FLOW CUTOFF (0=OFF)	0.00	30.00	0.00	2	

Notes:

1. **The quantity of Inputs available is dependent on the type of option board installed. An error message is displayed during EXIT S/M if sufficient Inputs are not available.**
2. **The difference between Parameters 3 & 4 must be greater or equal to 0.500 Volts.**
3. **Reverse Input scaling is valid, i.e. 0% Output = 5.000 Volts, 100% Output = 0.000 Volts.**
4. **Negative Inputs (after 0% and 100% scaling) yield a 0% Output if Square Root mode is selected**

F5 [RAIN] (RS485) Remote Analog Input

When the PCC III RS485 communications link (Comm Link) is in "Local Mode", the Comm Link can read all Block Outputs; however, the Comm Link is prevented from writing data to (ie changing) all Block Outputs, with the exception of the **RAIN** and **RDIN** Blocks. The Comm Link is permitted to write data to **RAIN** and **RDIN** Block Outputs at all times.

Signal Conditioning: The value written by the Comm Link first passes through a min/max limiter, followed by a %/sec rate limiter, and then a first order low pass digital smoothing filter. The result of the digital filter becomes the **RAIN** Block Output. By setting parameters 1-4, any or all of these signal conditioners can be turned off.

The Comm Link scaling is: (Block Output*100). That is, when Comm Link writes 5047, PCC III interprets the value as 50.47%. A **RAIN** Block Output of 17.01% is reported to the Comm Link as 1701. The limiting and filtering discussed above can cause the value written by Comm Link to be different from the **RAIN** Block Output that is read by Comm Link. **RAIN** will not indicate an error to the Comm Link if Comm Link writes a value outside of the min/max limits.

Timeout: The value written by Comm Link remains in effect until a new value is written, or until a Comm Link time-out. Upon Comm Link time-out (ie no new message received within x sec., parameter 5), **RAIN** can either remain at the last value or switch to the default value (parameters 6 and 7). If **RAIN** switches to the default, the signal conditioning is applied to smooth the transition.

At power down, the Block Output is saved in the Retentive Memory area of the EEPROM. During the first scan after CPU start-up, the **RAIN** Block Output is set to the value stored in the Retentive Memory. If Retentive Memory is invalid, the Block Output initializes to the Default Output value upon CPU start-up.

```
-------------------------------------------------------------------------------------------
FUNCTION:  5          TEMP BYTES:   8      RETENTIVE BYTES:   0         DATA BYTES:  36
NAME:      RAIN                       SINGLE USE FUNCTION:   N        OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
No Inputs

Parameter          Description                Default     Max       Min        Code   Notes
_____________________________________________________________________________________________
  1          MIN OUTPUT                        0.00    199.99   -199.99       2      1
  2          MAX OUTPUT                      100.00    199.99   -199.99       2      1
  3          %/SEC RATE LIMITER (100=OFF)    100.00    100.00      0.10       2      2
  4          FILTER SECONDS                    0.00      3.00      0.00       2      x
  5          COMM FAIL DELAY SEC.              5        3600         1       2      x
  6          FAIL ACTION, 0=LAST, 1=DEFAULT    0           1         0       2      x
  7          FAIL DEFAULT                      0.00    199.99    -199.99      2      x

Notes:
1.  MIN must be less than MAX.
2.  100.00%/sec rate limit turns off Rate Limiting
```

F11 [DUAL] Dual Range Flow Transmitter Selector-Scaler

Function **DUAL** is used to automatically select and scale one of two flow transmitters in a dual range arrangement. This allows greater measurement accuracy over a wider flow range.

Example: An orifice plate with two differential pressure transmitters piped in parallel. The High range transmitter is calibrated 0-100" WC, the Low range transmitter is calibrated 0-9" WC. The **DUAL** Block should be set to a 9% switch point, with the square root option selected (the transmitters should NOT have internal square root selected).

From 100" – 9" WC, the High range Input would be selected, square rooted, and sent to the **DUAL** Block Output as a 100-30% signal. Below 9" WC, the Low range would be selected, the transmitter signal would be scaled, square rooted, and sent to the **DUAL** Block Output as a 30-0% signal.

Formula (shown with optional square root being taken):

If High Range Input greater than Switch Point:
Output = 10 * square root[High Range Input]
Else
Output = 10 * square root[(Low Range Input * Switch Point) / 100]

```
-------------------------------------------------------------------------------------------
FUNCTION:  11         TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:  16
NAME:      DUAL                       SINGLE USE FUNCTION:   N        OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
Input    Type          Description                                          Notes
_____________________________________________________________________________________________
  1        A       HI RANGE INPUT
  2        A       LOW RANGE INPUT                                          1

Parameter          Description                Default     Max       Min        Code   Notes
_____________________________________________________________________________________________
  1          SWITCHING POINT (% OF HIGH
               RANGE                           10.00     50.00      1.00       2      2
  2          SQUARE ROOT? 0=NO 1=YES            1         1         0         2

Notes:
1. Low Range Input MUST be scaled to match the Switch Point and the High Range transmitter.
     Example: High Range transmitter is 0-120" WC for 4-20 mA, or 0-100% inside the PCC III,
     If the Switch point is 10%, the Low range transmitter MUST be calibrated 0–12.0" wc for
     0-100%.
2. Percent of High Range Input.
```

F20 [OPLR] Optical Path Length Ratio Correlation for Opacity Monitors

with Opacity Output / Optical Density Output Mode Selection
(ROM 2.23 and 3.01 and higher)

Function **OPLR** is a special purpose function that is used to convert a double pass opacity monitor's T^2 (Transmittance$^{2)}$ signal to a stack exit diameter corrected Opacity signal. The Block Input signal must be 0-100% Transmittance^2. The 0-100% Block Output can represent either OPLR corrected 0-100% Opacity, or OPLR corrected 0.000 – 1.000 Optical Density.

If the duct inside diameter at the Opacity monitor location is the same as the stack exit inside diameter, set OPLR=0.500. If the monitor and stack exit diameters are different, use the following formulas to find OPLR corrected Opacity:

Lm = The inside diameter (or width) of the flue at the Opacity Monitor location (in inches)
Lx = The inside diameter (or width) of the stack at the outlet (in inches)
OPLR = [0.5 * (Lx / Lm)]
Ox = Opacity at the stack exit = $1 - (T^2)^{OPLR}$

T^2 and Ox are expressed as decimal percentages (i.e., 0.92 instead of 92%) in the above equations.

In Opacity Output Mode (Parameter 1 = 1), the Block Output is scaled 0-100% for Ox = 0.00 – 1.00. Opacity can not be less than 0% or greater than 100%. However, values greater than 100%, and less than 0% are calculated to allow system trouble shooting.

Pursuant to Federal EPA regulations, the OPLR constant can not be altered in the field. The OPLR constant can only be adjusted by the transmissometer manufacturer, and is protected by a level 4 Factory password.

Optical Density (Od) is calculated based on OPLR corrected Opacity (Ox): Od = - log(1 – Ox)

In Optical Density Output Mode (Parameter 1 = 0), the Block Output is scaled 0-100% for Ox = 0.00 – 1.00. Optical Density Block Output values greater than 100% are calculated to allow system trouble shooting.

Optical Density is proportional to particulate emissions (gr/ft^3 or mg/mm^3). Using EPA certified methods, measure particulate emissions, and note the Optical Density during the measurement. Then use a SCALE Block to convert Optical Density to Particulates (X1 = Y1 = 0.0, X2 = Ox * 100, Y2 = measured Particualtes in %).

FUNCTION: 20	TEMP BYTES: 0	RETENTIVE BYTES: 0	DATA BYTES: 12
NAME: OPLR		SINGLE USE FUNCTION: N	OUTPUT TYPE: A

Input	Type	Description	Notes
1	A	T^2 INPUT	

Parameter	Description	Default	Max	Min	Code	Notes
1	MODE: 1=OPACITY,0=OPTICAL DENSITY	1	1	0	3	
2	OPLR	0.500	3.000	0.200	4	

F22 [BEFF] Boiler Efficiency

Function **BEFF** calculates Boiler or Process Heater Efficiency based upon the ASME Efficiency Test using the Losses Method. For fuels with a known chemical composition (Natural Gas, Oils, …), this method is a more reliable means of calculating efficiency than Input-Output based calculations. This method also applies to solid fuels (wood, coal, …), however, more frequent fuel analysis and resultant parameter corrections are required to account for moisture and chemical changes.

BEFF (and ASME) takes into account boiler casing radiation losses and miscellaneous fixed percentage losses (blowdown, unburned fuel, …). Most portable combustion analyzers do not account for these losses and will typically indicate combustion efficiency, not boiler efficiency. Therefore most portable combustion analyzers will indicate a higher efficiency than the **BEFF** (and ASME) method.

Default Fuels: The "Fuel A" default Parameters below are for #6 fuel oil, "Fuel B" defaults are for Natural Gas. Contact Preferred Instruments for Parameter values for other fuels.

FUNCTION: 22 TEMP BYTES: 0 RETENTIVE BYTES: 0 DATA BYTES: 128
NAME: BEFF SINGLE USE FUNCTION: N OUTPUT TYPE: A

Input	Type	Description	Notes
1	A	EXIT TEMPERATURE INPUT	1
2	A	AMBIENT TEMP INPUT	1,2
3	A	% OXYGEN INPUT	1
4	A	PPM CO INPUT	1,3
5	A	% FIRING RATE INPUT	1
6	D	FUEL SELECT INPUT (0 = FUEL A, 1 = FUEL B)	4

Parameter	Description	Default	Max	Min	Code	Notes
1	% O2 FULL SCALE	10.00	25.00	10.00	2	
2	PPM CO FULL SCALE	1000	5000	1000	2	
3	EXIT TEMPERATURE FULL SCALE	1000	2000	300	2	
4	AMBIENT TEMPERATURE FULL SCALE	100	1000	100	2	
5	% LOSS DUE TO RADIATION AT 100% FIRING RATE	0.75	5.00	0.00	2	5
6	% LOSS DUE TO MISC FIXED LOSSES	1.00	5.00	0.00	1	
	Fuel A Components: Moles/Unit of Fuel Burned (Default = #6 Oil)					6
7	FUEL A MOLES OF C	7.377	12.000	0.000	2	
8	FUEL A MOLES OF H2	3.175	6.000	0.000	2	
9	FUEL A MOLES OF S	0.027	6.000	0.000	2	
10	FUEL A MOLES OF N2	0.011	2.000	0.000	2	
11	FUEL A MOLES OF O2	0.022	2.000	0.000	2	
12	FUEL A MOLES OF H2O	0.011	5.000	0.000	1	
13	FUEL A HEATING VALUE MILLIONS OF BTUS/UNIT OF FUEL	1.812	2.500	0.100	2	
	Fuel B Components: Moles/Unit of Fuel Burned (Default = Nat. Gas)					6
14	FUEL B MOLES OF C	1.050	12.000	0.000	2	
15	FUEL B MOLES OF H2	2.000	6.000	0.000	2	
16	FUEL B MOLES OF S	0.000	6.000	0.000	2	
17	FUEL B MOLES OF N2	0.050	2.000	0.000	2	
18	FUEL B MOLES OF O2	0.000	2.000	0.000	2	
19	FUEL B MOLES OF H2O	0.000	5.000	0.000	1	
20	FUEL B HEATING VALUE MILLIONS OF BTUS/UNIT OF FUEL	0.409	2.500	0.100	2	

Notes:

1. All analog input signals must be "zero" based. O% Input = 0 deg. F, 0% Oxygen, 0 ppm CO, 0% Btu Input. Non-zero based signals can be converted with a SCALE (F45) Block.
2. If the CO signal is not available, connect Block 0 (A0%) to this Input.
3. This Input is 0-100% Fuel Btu Input, NOT 0-100% of operating range. If a burner has an 8:1 turndown, this Input should be 12.5% at low fire. A SCALE (F45) Block can be used to convert a 0-100% operating range to Fuel Input %. This Input only affects the Radiation (ie boiler sheathing) losses.
4. 0 = Fuel A = (#2 Oil by default), 1 = Fuel B = (Natural Gas by default)
5. Radiation (boiler sheathing) heat loss is a nearly constant Btu/hr rate (ie, a fixed quantity, but not a fixed percentage of Btu Input)). Enter as a Percentage of maximum firing rate Btu Input. Radiation Loss = [(Parm 5 * 100) / Input 5]
6. Typical "Units of Fuel" are:

Liquid and Solid Fuels:	Moles/100 lbs. Fuel burned
	Million Btu/100 lbs Fuel burned
Gaseous Fuels:	Moles/Mole of Fuel burned
	Million Btu/Mole of Fuel burned

7. Contact Preferred Instruments for Parameter values for other fuels. Constants for any fuel can be calculated if the chemical analysis of the fuel is known.

F31 [HSEL] High Select

Function **HSEL** selects the greater of the three Inputs and copies that value to it's Block Output. If there are only two Inputs, connect either one of the two active Input Block numbers to the third Input.

```
-------------------------------------------------------------------------------------------
FUNCTION:  31          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:  12
NAME:      HSEL                     SINGLE USE FUNCTION:   N        OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
Input    Type          Description                                          Notes
___________________________________________________________________________________________
  1        A       A INPUT
  2        A       B INPUT
  3        A       C INPUT

No Parameters
```

F32 [LSEL] Low Select

Function **LSEL** selects the lowest (i.e. smaller) of the three Inputs and copies that value to it's Block Output. If there are the only two Inputs, connect either one of the two active Input Block numbers to the third Input.

```
-------------------------------------------------------------------------------------------
FUNCTION:  32          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:  12
NAME:      LSEL                     SINGLE USE FUNCTION:   N        OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
Input    Type          Description                                          Notes
___________________________________________________________________________________________
  1        A       A INPUT
  2        A       B INPUT
  3        A       C INPUT

No Parameters
```

F33 [MSEL] Median Selector

Function **MSEL** selects the median (ie, middle) of the three Inputs and copies that value to it's Block Output. Examples:

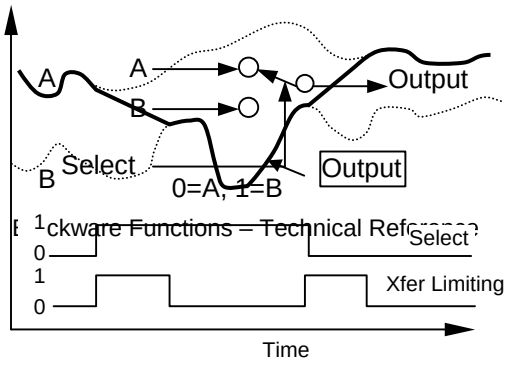
A Input	B Input	C Input	Block Output
10 %	15%	14%	14%
5 %	- 10%	12 %	5 %
77 %	78 %	78 %	78 %

If this function is configured with only two active Inputs, the third Input will be the default Block 0 [A0%]. In this case, the Median selection would compare the two active Inputs to 0%.

```
FUNCTION:  33          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:  12
NAME:      MSEL                     SINGLE USE FUNCTION:   N        OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
Input    Type          Description                                          Notes
___________________________________________________________________________________________
  1        A       A INPUT
  2        A       B INPUT
  3        A       C INPUT

No Parameters
```

F34 [ASW] Analog Switch

Function **ASW** is used to switch the Block Output between one of two analog Input signals under control of a discrete (on/off) Select signal. The concept is very similar to a SPDT relay or 3



port solenoid valve. When the Select signal is 0 (low) the "A" analog Input is selected and passed to the **ASW** Block Output. When Select = 1 (high), the "B" signal is passed to the Output.

Transfer Rate Limiting: When Parameter 1 = 0 (Transfer Rate Limiting is OFF), the Block Output changes instantaneously when the Select Input changes.

When Parameter 1 = 1 (Transfer Rate Limiting is ON), the rate of change of the Block Output signal is limited for the duration of the transfer. After the Block Output becomes equal to the selected Input, the rate limiting is disabled and the Output will track the selected Input with no rate of change limiting. Independent rate of change limits are provided for A to B, and B to A transfers.

The Transfer Rate of Change feature can be used to provide bumpless transfer, and for ramp generators.

FUNCTION:	34	TEMP BYTES:	0	RETENTIVE BYTES:	0	DATA BYTES:	32
NAME:	ASW			SINGLE USE FUNCTION:	N	OUTPUT TYPE:	A

Input	Type	Description	Notes
1	A	A INPUT	
2	A	B INPUT	
3	D	SELECT INPUT (0 = A Input, 1 = B Input)	1

Parameter	Description	Default	Max	Min	Code	Notes
1	XFER RATE LIMITING 0=OFF 1=ON	0	1	0	2	2
2	A TO B %/SEC RATE LIMIT	1.00	100.00	0.10	2	
3	B TO A %/SEC RATE LIMIT	1.00	100.00	0.10	2	

Notes:
1. **Output = "A" Input when "Select" = 0, Output = "B" Input when "Select" = 1**
2. **When "Xfer Rate Limiting" = 0, the Output changes instantaneously when "Select" changes.**

F35 [H/LLIM] High / Low Signal Limiter

Function **H/LLIM** passes the Input to the Block Output if the value is less than Parameter 1 (Hi Limit), and greater than Parameter 2 (Low Limit). If the Input is outside of these limits, the Block Output is held at the appropriate limit value. The limits can be positive/positive, positive/negative, or negative/negative; however, the Hi Limit must be greater than the Low Limit.

FUNCTION:	35	TEMP BYTES:	0	RETENTIVE BYTES:	0	DATA BYTES:	12
NAME:	H/LLIM			SINGLE USE FUNCTION:	N	OUTPUT TYPE:	A

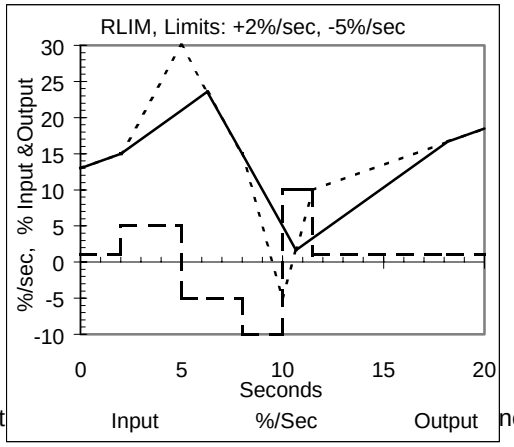
Input	Type	Description	Notes
1	A	INPUT	

Parameter	Description	Default	Max	Min	Code	Notes
1	HI LIMIT	100.00	199.99	-199.98	2	1
2	LOW LIMIT	0.00	199.98	-199.99	2	1

Notes:
1. **The Hi Limit MUST be greater than the Low Limit.**

F36 [RLIM] Rate Limiter

Function **RLIM** compares the %/sec rate of change of the Input analog signal to Parameter 1 (increasing) & 2 (decreasing) rate of change limits. Whenever the Input rate of change is between the two limits, the Input is passed to the Block Output. If the Input rate of change exceeds either limit, the Output will ramp at the appropriate rate limit until the Output becomes equal to the Input.



The Input rate of change is ignored during the output rate limiting mode. Therefore, if the Input rate of change briefly exceeds one of the limits, and then returns to a moderate

rate, the Block Output will lag behind the Input until the Output becomes equal to the Input again.

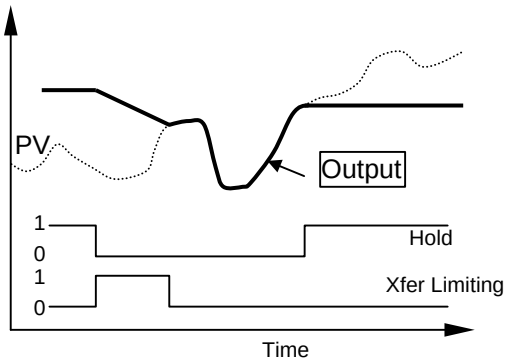
FUNCTION: 36	TEMP BYTES: 0	RETENTIVE BYTES: 0	DATA BYTES: 20
NAME: RLIM		SINGLE USE FUNCTION: N	OUTPUT TYPE: A

Input	Type	Description	Notes
1	A	INPUT	

Parameter	Description	Default	Max	Min	Code	Notes
1	+ %/SEC LIMIT	10.00	100.00	0.10	2	
2	- %/SEC LIMIT	-10.00	-0.10	-100.00	2	

F38 [FPT/H] Front Panel Adjustable Track / Hold

Function **FPT/H** is a Track/Hold that allows the Operator to adjust the Block Output from the Front Panel display when the Block is in Hold mode. It's function is equivalent to an Auto/Manual, or Remote/Local station.



Track Mode: When the Block is in Track mode (similar to Auto or Remote), the Block Output is set equal to the "Signal" Input. That is, the Block Output "tracks" the Block Input.

Hold Mode: When the Block is in Hold mode (similar to Manual or Local), the Block Output remains at the last value unless changed by the Operator or the RS485 communications link. In Hold mode, if the Operator selects a **FPT/H** Block for display on the front panel, the Block Output can be changed with the front panel UP-DOWN arrows. After the Operator completes the change, the Block Output will remain at the last value until the next Operator change or until the Block goes into Track mode. The **FPT/H** Block must be configured as an Input to the **PANEL** Block in order to allow changes from the front panel. In Hold mode, the RS485 communications link can change the Block output by writing a new value to the Block Output (see Section 7).

Mode Selection: The Track/Hold mode is normally determined by the "Hold Select" Input (0 = Track mode, 1 = Hold mode). However, the optional Track Override Inputs can override the "Hold Select" Input. If either "Track Override" Input is set to a discrete "1", the "Hold Select" Input is ignored and the Block is forced into the Track mode (see below). If no Blocks are connected to these Inputs, the default Block 2 (Discrete 0) Inputs disable the override feature.

TRACK OVERRIDE 1	TRACK OVERRIDE 2	HOLD	Track/Hold Mode
0	0	0	Track
0	0	1	Hold
0	1	not used	Track
1	0	not used	Track
1	1	not used	Track

Transfer Rate Limiting is OFF when Parameter 3 (Transfer Rate Limit) equals 100%/sec, and the transfer from Hold mode to Track Mode is instantaneous. That is, the Block Output is set equal to the Signal Input during the first scan of the mode change.

Transfer Rate Limiting is ON when the Transfer Rate Limit is less than 100%/sec. The rate of change of the Block Output signal is limited to (Parameter 3) %/sec for the duration of the transfer from the last Hold mode Block Output to the current Signal Input. When the Block Output becomes equal to the Signal Input, the rate limiting is disabled and the Output will track the Signal Input with no rate of change limiting. The Transfer Rate of Change feature is used primarily to provide bumpless transfer.

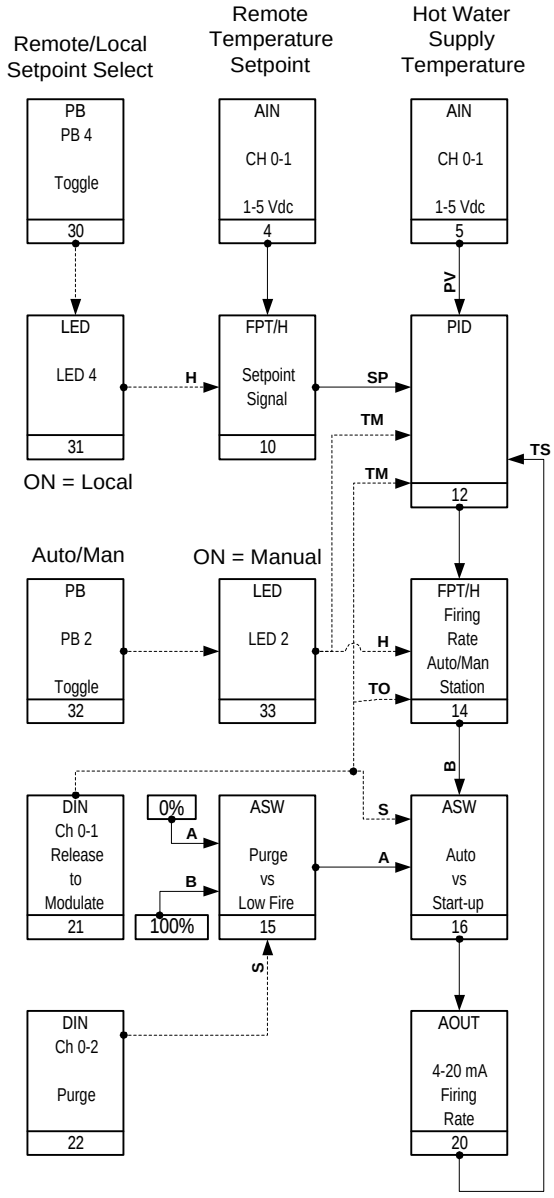
In ALL cases, the Block Output is limited to the Min and Max Output values set in Parameters 1 & 2.

For applications that only require a simple Track/Hold function without any Operator adjustment capability, simply use **FPT/H** without connecting **FPT/H** to a front panel display channel.

At power down, the Block Output is saved in the Retentive Memory area of the EEPROM. During the first scan after CPU start-up, the **FPT/H** Block Output is set to the value stored in the Retentive Memory.

The Blockware Example shows typical applications of the FPT/H function. Block 14 is the **FPT/H** Manual/Auto station for the control loop. Before the burner releases to modulation, the **FPT/H** "TO" Input and the **PID** "TM" Input force both Blocks to Track the Firing Rate Output (Block 20). This insures a bumpless, balanceless transfer from light-off to modulate.

The second **FPT/H**, Block 10, is used to implement a remote setpoint with local manual override strategy. In Remote mode the **PID** setpoint will be the Remote setpoint. When the Operator presses the pushbutton to put the controller in Local setpoint mode, the setpoint will initially be held at the most recent remote setpoint, and the Operator can then adjust it to any desired value. The Transfer Rate Limiting would be used to prevent a rapid setpoint change when transferring from Local Setpoint mode back to Remote Setpoint mode.




```
-------------------------------------------
-------------------------------------------
FUNCTION:  38          TEMP BYTES:   0      RETENTIVE BYTES:   4        DATA BYTES:  32
```

NAME: FPT/H **SINGLE USE FUNCTION:** N **OUTPUT TYPE:** A

Input	Type	Description		Notes
1	A	SIGNAL INPUT		
2	D	HOLD SELECT INPUT	(1 = HOLD)	1
3	D	TRACK OVERRIDE INPUT	(1 = TRACK)	1
4	D	TRACK OVERRIDE INPUT	(1 = TRACK)	1

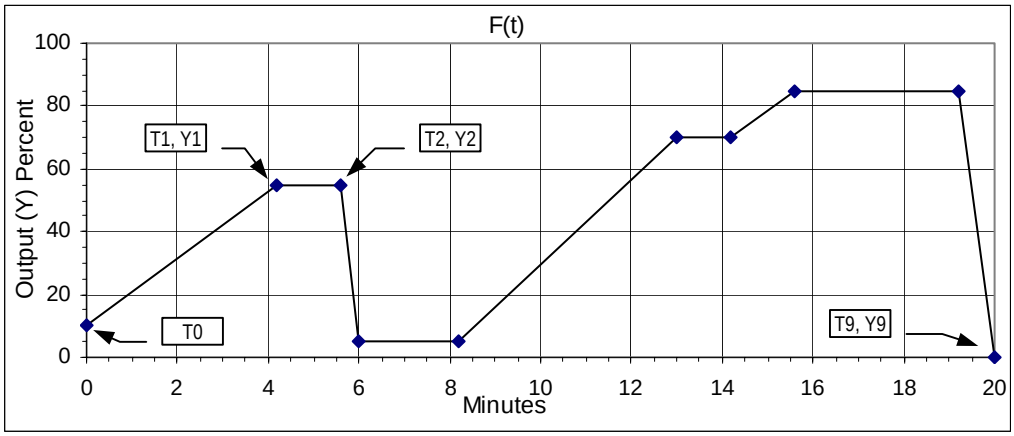
Parameter	Description	Default	Max	Min	Code	Notes
1	MIN OUTPUT	0.00	199.99	-199.99	2	2
2	MAX OUTPUT	100.00	199.99	-199.99	2	2
3	%/SEC TRANSFER LIMIT (100%=OFF)	100.00	100.00	0.10	2	

Notes:
1. See Track / Hold truth table above.
2. Max Output MUST be larger than Min Output limit.

F41 [F(T)] Function of Time Generator

Function **F(T)** generates a Block Output based on a user generated output vs time profile. The parameters provide an initial (y_0) Block Output value (at time = 0.0 min), plus 10 additional (y,t) breakpoint pairs. Between each breakpoint pair, the function ramps in a straight line fashion from breakpoint to breakpoint (see the figure below). Individual segment slopes from 600%/min to 0.01%/min can be generated.

A typical application is temperature setpoint generation for Heating or Cooling Ramp/Soak cycles.



Less than 10 Breakpoints: All ten breakpoints do not have to be used, the **F(T)** function ignores all breakpoints after the first T_i= 0.0 is encountered. Breakpoints 4 through 10 (inclusive) would be ignored in this example: Y0=10%; (Y1=20%,T1=10.0); (Y2=20%,T2=20.0); (Y3=30%,T3=30.0); (Y4=0%,T4=0.0).

Reset and Hold Inputs: The Reset Input sets and holds the clock at 0.0 minutes whenever the Reset Input is "1". If the Hold Input is "0", the clock will start to run when the Reset Input is "0". Setting the Hold Input to "1" stops the clock, and the time will remain at that value until the Hold Input returns to "0", at that point the clock resumes running from the held value onward (see chart).

Reset Input	Hold Input	Clock
1	not used	0.0 min
0	0	Run / Resume
0	1	Stop and Hold

Auto-Recycle: If Parameter 1 (Auto Recycle) = 0, the Block Output will remain at Y_i, when the clock reaches the last valid T_i. If Parameter 1 (Auto Recycle) = 1, when the clock reaches the last valid T_I, the clock resets to 0.0 min and repeats the ramp sequence.

At power down, the clock run time is saved in the Retentive Memory area of the EEPROM. During the first scan after CPU start-up, the clock run time is set to the value stored in Retentive Memory. This feature can be bypassed by forcing the Block logic to set the Reset Input = 1 at power-up.

FUNCTION: 41 TEMP BYTES: 16 RETENTIVE BYTES: 3 DATA BYTES: 96
NAME: F(T) SINGLE USE FUNCTION: N OUTPUT TYPE: A

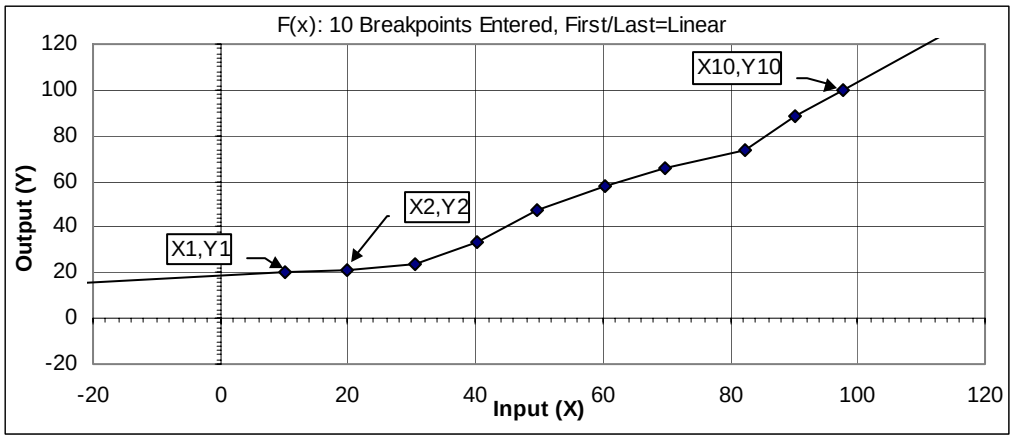
Input	Type	Description	Notes
1	D	HOLD INPUT (1=HOLD)	1
2	D	RESET INPUT (1=RESET)	1

Parameter	Description	Default	Max	Min	Code	Notes
1	AUTO RECYCLE 0=NO 1=YES	0	1	0	2	
2	Y0 %	0.00	150.00	-150.00	2	
3	T1 MINUTES	0.0	1999.9	0.0	2	2
4	Y1 %	0.00	150.00	-150.00	2	
5	T2 MINUTES	0.0	1999.9	0.0	2	2
6	Y2 %	0.00	150.00	-150.00	2	
7	T3 MINUTES	0.0	1999.9	0.0	2	2
8	Y3 %	0.00	150.00	-150.00	2	
9	T4 MINUTES	0.0	1999.9	0.0	2	2
10	Y4 %	0.00	150.00	-150.00	2	
11	T5 MINUTES	0.0	1999.9	0.0	2	2
12	Y5 %	0.00	150.00	-150.00	2	
13	T6 MINUTES	0.0	1999.9	0.0	2	2
14	Y6 %	0.00	150.00	-150.00	2	
15	T7 MINUTES	0.0	1999.9	0.0	2	2
16	Y7 %	0.00	150.00	-150.00	2	
17	T8 MINUTES	0.0	1999.9	0.0	2	2
18	Y8 %	0.00	150.00	-150.00	2	
19	T9 MINUTES	0.0	1999.9	0.0	2	2
20	Y9 %	0.00	150.00	-150.00	2	
21	T10 MINUTES	0.0	1999.9	0.0	2	2
22	Y10 %	0.00	150.00	-150.00	2	

Notes:
1. **See chart above for REST and HOLD Input operation.**
2. **Times must be entered in ascending order. Starting from T0 and scanning toward T10, all breakpoints after the first Ti = 0.0 will be ignored.**

F42 [F(X)] Function of X Generator with Learn Mode

Function **F(X)** generates a Block Output based on a user generated Output vs Input profile (ie, y=f(x)). The parameters provide 11 (X,Y) breakpoint pairs. Between adjacent breakpoints, **F(X)** "draws" a straight line from breakpoint to breakpoint (see the figure below).



Less than 11 breakpoints: All eleven breakpoints do not have to be used. Starting from X1, **F(X)** ignores all breakpoints after the first X_i= -150.00 is encountered. Example: Y1=10%, X1=0.00%; Y2=22%, X2=20.00%; Y3=29%, X3=30.0; Y4=0%, X4=-150.00. Breakpoints 4 through 11 (inclusive) would be ignored in this example. The X coordinates can be any value; however, the X values must be entered in ascending order (ie X1 < X2 < X3 < X4 …).

First/Last Segments: For X Inputs below the first or above the last defined breakpoints, the Block Output can be held at the last valid Y value (Hold mode), or the Block Output can vary according to the last valid line segment equation (Linear mode). Parameter 1 (First/last Segment) = 0 holds the Output, Parameter 1 = 1 varies the Output linearly. The figure above illustrates Linear mode. At least two points must be entered to activate Linear Mode.

Learn Mode

X and Y coordinates may be entered or modified at any time from the PCC III front panel editor, the RS232 port, or the RS485 communications port (via PLINK). **F(X)** also has a **Learn** mode for automated entry and editing of characterizing curves. **Learn** mode is particularly useful for setting up the various curves associated with combustion applications: fuel/air ratio, oxygen setpoint, flue gas recirculation curves, furnace draft feedforward, and feedwater valve characterizer curves.

When Input 2 (Learn Enable) = 1 the **Learn** mode is activated and Inputs 3, 4, and 5 determine how **Learn** mode operates. Inputs 3-5 are ignored when Input 2 (Learn Enable) = 0. The Block Output continues to be calculated based on the X input and the current parameters throughout **Learn** mode. See the truth table below:

Learn Enable Input	Learn Input	Clear Input	Action
0	not used	not used	Learn mode is disabled
1	0	not used	No (X,Y) data is stored in the parameters
1	1	not used	No (X,Y) data is stored in the parameters
1	^1	0	The current X and Y Input values are stored in a pair of parameters (see below)
1	^1	1	All X and Y parameters are reset to the default values

NOTE: **^1** means: on the rising edge (i.e., only once during the scan that the Input changes from 0 to 1)

Automated Storing of (X,Y) Data in Learn Mode:
If the Learn Enable Input = 1, and Clear Input = 0, Then: During the first scan that the Learn Input changes from 0 to 1; the current X and Y Inputs are stored in a (X_i ,Y_i) parameter pair. The rules for selecting the (X_i ,Y_i) parameter pair are as follows:

If less than 11 "active X" Parameters exist (ie, X_i > –150.00%):

Is the current "X" Input within +/- 2.00% of an existing "X" Parameter?

Yes: Replace the existing (X,Y) parameter values with the "X" and "Y" Inputs. This allows you to "Edit" an existing "Y" value using Learn Mode.

No: Store the current "X" and "Y" Inputs in a new (X_i ,Y_i) parameter pair such that the "X" values remain in ascending order (ie X1 < X2 < X3 < X4 …). **F(X)** automatically moves all (X,Y) parameter pairs above X_i up one position.

If 11 active "X" Parameters exist:

Replace the existing breakpoint (X,Y) parameter pair that is closest to the current "X" value with the current "X" and "Y" Inputs.

The above process only occurs during the first scan that the Learn Input changes from 0 to 1. If Learn = 1 for more than one scan, the subsequent scans do not "Learn" any additional values.

"Clearing" (X,Y) Data
If the Learn Enable Input = 1, and Clear Input = 1, Then: During the first scan that the Learn Input changes from 0 to 1; all eleven "Y" parameters are set equal to Parameter 24, the "Y VALUES AFTER CLEAR" parameter. All eleven "X" Parameters are set equal to -150.00% (ie, inactive). This allows the Block Output to be set to a defined value until a new curve is entered.

Blockware Example: The Blockware on the next page shows a simplified parallel positioning combustion control application that uses two **F(x)** Blocks. The **F(x)** in Block 55 holds the fuel-to-air characterizing curves for one fuel. The **F(x)** in Block 62 holds the Oxygen Setpoint versus Load (Ie Firing Rate) characterizing curves for one fuel. A second or third fuel could be accomodated by adding additional **F(x)** Blocks and **ASW** Blocks to select the correct **F(x)** Block based on the fuel currently being fired.

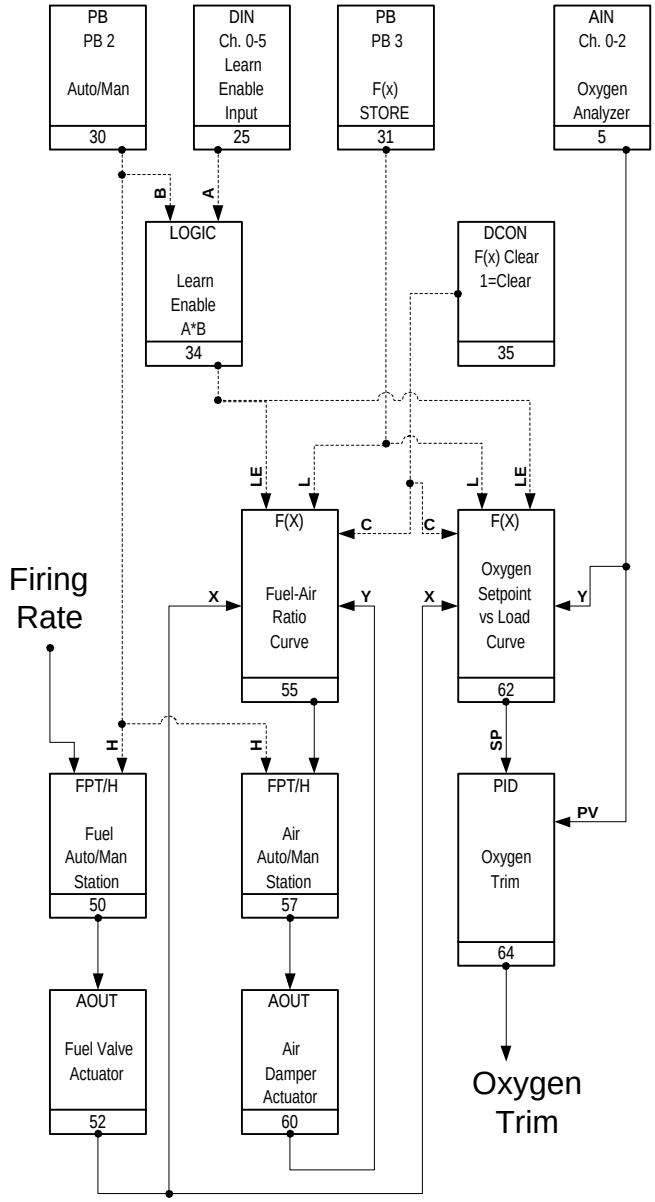
WARNING: This simplified example does not show all of the required safety features that would be included in a real combustion control strategy. Do not use the Blockware example shown for an actual application.

The Blockware is configured to use Learn Mode for simultaneous entry of the fuel/air and Oxygen Setpoint/Load **F(x)** curves. The gerneral procedure a Burner Technician would follow is:

1.) Enable Learn Mode
2.) Put BOTH the Fuel and Air Acutaors in Manual
Manually position the Fual and Air at Minimum Firing Rate for best combustion
Allow the Oxygen Analyzer signal to stabilize
Press the front panel pushbutton that is configured as the "STORE" button.
Block 55 will add an (X,Y) breakpoint for the current fuel (X) and air (Y) positions.
Block 62 will add an (X,Y) breakpoint for the current fuel (X) and Oxygen (Y) Levels.
3.) Repeat the above 4 steps at 10 additional firing rates (less if applicable). Make sure that the Maximum firing rate is "Stored".
4.) Disable Learn Mode

WARNING: In a combustion application, it is not safe to leave the Learn Mode enabled during normal operation. An accidental "Store" operation would instantly change the fuel/air ratio. The Blockware should include sufficient logic and interlocks to prevent unsafe conditions.

The example below requires an external "Learn Enable" input to be a “1” (**DIN** Block 25), and both the fuel and air must be in Manual before “Learn Mode” is enabled. A **DCON** could also be used as a permissive, **DCON** requires a "Technician" level password to enable changing it's Parameter.



WARNING: This simplified example does not show all of the required safety features that would be included in a real combustion control strategy. Do not use the Blockware example shown for an actual application.

FUNCTION: 42	TEMP BYTES: 4	RETENTIVE BYTES: 0	DATA BYTES: 116
NAME: F(X)	SINGLE USE FUNCTION: N	OUTPUT TYPE: A	

Input	Type	Description	Notes
1	A	X INPUT	
2	D	LEARN ENABLE INPUT (1=ENABLE)	1
3	D	LEARN INPUT (^1=LEARN)	2,3
4	D	CLEAR INPUT (^1=CLEAR)	2,4
5	A	Y INPUT	5

Parameter	Description	Default	Max	Min	Code	Notes
1	FIRST/LAST SEGMENT 0=HOLD 1=LINEAR	0	1	0	2	
2	X1	0.00	150.00	-150.00	2	6
3	Y1	0.00	150.00	-150.00	2	
4	X2	100.00	150.00	-150.00	2	6
5	Y2	100.00	150.00	-150.00	2	
6	X3	-150.00	150.00	-150.00	2	6
7	Y3	50.00	150.00	-150.00	2	
8	X4	-150.00	150.00	-150.00	2	6
9	Y4	50.00	150.00	-150.00	2	
10	X5	-150.00	150.00	-150.00	2	6
11	Y5	50.00	150.00	-150.00	2	
12	X6	-150.00	150.00	-150.00	2	6
13	Y6	50.00	150.00	-150.00	2	
14	X7	-150.00	150.00	-150.00	2	6
15	Y7	50.00	150.00	-150.00	2	
16	X8	-150.00	150.00	-150.00	2	6
17	Y8	50.00	150.00	-150.00	2	
18	X9	-150.00	150.00	-150.00	2	6
19	Y9	50.00	150.00	-150.00	2	
20	X10	-150.00	150.00	-150.00	2	6
21	Y10	50.00	150.00	-150.00	2	
22	X11	-150.00	150.00	-150.00	2	6
23	Y11	50.00	150.00	-150.00	2	
24	Y VALUE AFTER CLEAR	100.00	150.00	-150.00	2	

Notes:

1. 1 = Learn Mode enabled, 0 = disabled.
2. This Input is ignored if LEARN ENABLE Input = 0.
3. The Learn Event is active during the single scan when the LEARN Input changes from 0 to 1, AND (LEARN ENABLE Input equals 1 and CLEAR Input equals 0).
4. The Clear Event is active during the single scan when the LEARN Input changes from 0 to 1, AND (LEARN ENABLE Input equals 1 and CLEAR Input equals 1).
5. The Y Input value is only used during the single scan of a Learn Event. The Input is limited to +/- 150.00%.
6. The X coordinates MUST be in ascending order, that is: $X_1 < X_2 < X_3 < X_4 \ldots < X_{11}$.
7. Xi = -150.00 indicates that the (X,Y) pair is inactive (ie, not being used). All inactive (X,Y) pairs must be the "upper" X's (i.e. X11, X10, X9, …). F(x) determines how many of the eleven (X,Y) breakpoints to use by starting at X1, and scanning up looking for the first Xi = -150.00. That pair and all pairs above it are ignored.

F43 [L/L] Lead – Lag with Gain (Dynamic Compensation)

Function **L/L** provides Lag, Lead, and Gain compensation in a single Block. Lag is a digital filter operation and is the first operation performed on the Input. Lead is a Derivative (or Rate) operation, and is performed on the result of the Lag filter. Gain is a simple multiplier that acts on the result of the Lead operation.

Lag and Gain operations can be used alone or in combination with any other operation. Lead requires Lag to be non-zero, and the ratio: (Lead seconds / Lag seconds) must be less than 15.

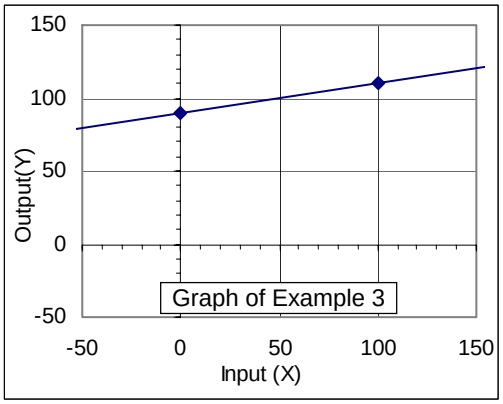
The Lag seconds is the time it takes for a step Input to drive the Output to 63% of the Input change. A larger value provides more damping.

The Lead Seconds is the derivative gain; that is: { Rate (%/Sec) * Lead (Sec) = % } . A larger value provides a larger response to a signal change.

```
-------------------------------------------------------------------------------------------
FUNCTION:  43          TEMP BYTES:  20      RETENTIVE BYTES:   0        DATA BYTES:  24
NAME:      L/L                          SINGLE USE FUNCTION:   N       OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
Input    Type          Description                                                Notes
-------------------------------------------------------------------------------------------
  1        A       PV INPUT

Parameter          Description                Default     Max       Min       Code   Notes
-------------------------------------------------------------------------------------------
  1          LAG SECONDS                          0      1800        0         2     1,2,3
  2          LEAD SECONDS                         0      1800        0         2     1,2,3
  3          GAIN                              1.00     20.00      0.01       2

Notes:
1.   0 = Off
2.   Lag seconds must be greater than 0, if Lead is greater than 0
3.   The ratio: (Lead Seconds / Lag Seconds) must be less than 15
```

F45 [SCALE] Signal Scaling

Function **SCALE** generates a Block Output based on two (X,Y) scaling points. X is the Block Input, and Y is the Block Output. The straight line defined by scaling points (X_1,Y_1) and (X_2,Y_2) continues beyond the two defined points and generates a Block Output within the +/- 327% limitations of the Input and Output. See examples below:



	Example 1		Example 2		Example 3	
Input (X):	X1= 0	X2= 100	X1= 0	X2= 50	X1= 0	X2= 100
Output (Y):	Y1= 50	Y2= 0	Y1= 0	Y2= 100	Y1= 90	Y2= 110

```
-------------------------------------------------------------------------------------------
FUNCTION:  45          TEMP BYTES:   0      RETENTIVE BYTES:   0        DATA BYTES:  20
NAME:      SCALE                        SINGLE USE FUNCTION:   N       OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
Input    Type          Description                                                Notes
-------------------------------------------------------------------------------------------
  1        A       SIGNAL INPUT

Parameter          Description                Default     Max       Min       Code   Notes
-------------------------------------------------------------------------------------------
  1          X1                                   0.00    150.00   -150.00     2
  2          Y1                                   0.00    150.00   -150.00     2
  3          X2                                 100.00    150.00   -150.00     2
  4          Y2                                 100.00    150.00   -150.00     2
```

F51 [AB/C] (A*B) / C Multiply - Divide

Function **AB/C** multiplies Input A by Input B, and then divides by Input C. **AB/C** then updates the Block Output with the result. Inputs within +/- 327% are acceptable, the Block Output is limited to +/- 327%.

Divide by Zero: If the C Input equals 0.00%, the Output will be set to 327.00% with the sign determined by the result A times B. For Example:

A	B	C	Output
100	100	100	100
50	100	100	50
100	100	50	200
75	51	50	76.50
-10	20	20	-10
10	1	0	+327
-1	0	0	-327

AB/C can be used for A*B multiplication (without dividing) by connecting Input C to dummy Block 1 (**A100** function, or 100%).

AB/C can be used for A/C division (without multiplying) by connecting Input B to dummy Block 1 (**A100** function, or 100%).

```
-------------------------------------------------------------------------------------------
FUNCTION:  51          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:  12
NAME:      AB/C                        SINGLE USE FUNCTION:   N        OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
Input    Type          Description                                            Notes
_____________________________________________________________________________________
  1        A       A INPUT
  2        A       B INPUT
  3        A       C INPUT

No Parameters
```

F52 [WSUM] Weighted Sum

Function **WSUM** computes the following "Weighted Sum" equation:

Output = ((Input A) * K1) + ((Input B) * K2) + ((Input C) * K3) + K4

Configured with three Inputs and using the default parameters, **WSUM** adds the three Inputs. **WSUM** does not require three active Inputs, connect un-used Inputs to dummy Block 0 (**A0** function, or 0%). Constants K1 through K4 allow **WSUM** to be used for addition, subtraction, averaging, and scaling.

WSUM Examples:

Application	Desired equation	Actual equation	K1	K2	K3	K4
Addition	A + B	(A*1.000)+(B*1.000)+((0%)*1.000)+0.00	1.000	1.000	n/a	0.00
Addition	A + B + C	(A*1.000)+(B*1.000)+(C*1.000)+0.00	1.000	1.000	1.000	0.00
Subtraction	A - B	(A*1.000)+(B*-1.00)+((0%)*1.000)+0.00	1.000	-1.000	n/a	0.00
Averaging	(A + B) / 2	(A*0.500)+(B*0.500)+((0%)*1.000)+0.00	0.500	0.500	n/a	0.00
Averaging	(A+B+C) / 3	(A*0.333)+(B*0.333)+(C*0.333)+0.00	0.333	0.333	0.333	0.00
Scaling: 0-100% xmtr Input is equivalent to 50-75% setpoint	0.25A + 50	(A*0.25)+(B*1.00)+((0%)*1.00)+50.00	0.250	n/a	n/a	50.00
Addition with Scaling (Weighted Sum) A: 0-100% = 0-50 gpm B: 0-100% = 0-150 gpm C: 0-100% = 0-200 gpm Output: 0-100% = 0-400 gpm	0.125A + 0.375B + 0.500C	(A*0.125)+(B*0.375)+(C*0.500)+0.00	0.125	0.375	0.500	0.00

Inputs within +/- 327% are acceptable, and the Block Output is limited to +/- 327%.

```
-------------------------------------------------------------------------------------------
FUNCTION:  52          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:  28
NAME:      WSUM                       SINGLE USE FUNCTION:   N        OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
Input    Type          Description                                            Notes
_____________________________________________________________________________________
  1        A       A INPUT
  2        A       B INPUT
  3        A       C INPUT

Parameter          Description                Default     Max       Min        Code   Notes
_____________________________________________________________________________________
  1          K1                                1.000    10.000   -10.000       2
  2          K2                                1.000    10.000   -10.000       2
  3          K3                                1.000    10.000   -10.000       2
  4          K4                                0.00    199.99   -199.99        2
```

F53 [INV] Invert

Function **INV** negates its analog Input; that is: Output = Input * -1
For example: a +21% Input is converted to a –21% Output.

```
-------------------------------------------------------------------------------------------
FUNCTION:  53          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:   4
NAME:      INV                        SINGLE USE FUNCTION:   N        OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
Input    Type          Description                                            Notes
_____________________________________________________________________________________
  1        A       INPUT

No Parameters
```

F54 [CON] Analog Constant

Function **CON** Outputs a user defined analog constant. This value can be changed via: the PCC III Editor menus (under password protection), via RS232 Blockware download, or via the RS485 communications link (using **PLINK** F124). This value cannot be changed from the PCC III front panel Operator displays during normal operation.

FUNCTION: 54 TEMP BYTES: 0 RETENTIVE BYTES: 0 DATA BYTES: 4
NAME: CON SINGLE USE FUNCTION: N OUTPUT TYPE: A

No Inputs

Parameter	Description	Default	Max	Min	Code	Notes
1	ANALOG CONSTANT VALUE	0.00	199.99	-199.99	2	

F55 [FPCON] Front Panel Adjustable Constant

Function **FPCON** outputs a user defined analog constant. This value can be changed via: the PCC III front panel Operator displays during normal operation, or via the RS485 communications link. This value can not be changed from the PCC III Editor menus, nor via the RS232 Blockware download. This function is used for Operator adjustable setpoints, ratios, channel selections, etc. …

A **FPCON** Block must be one of the 10 display channel Inputs to the **PANEL** (F96) Block in order to allow the Operator to be able to change the value from the front panel Operator displays. The MIN and MAX parameters limit the range of adjustment that can be made.

At power down, the Block Output is saved in the Retentive Memory area of the EEPROM. During the first scan after CPU start-up, the **FPCON** Block Output is set to the value stored in the Retentive Memory.

FUNCTION: 55 TEMP BYTES: 0 RETENTIVE BYTES: 4 DATA BYTES: 8
NAME: FPCON SINGLE USE FUNCTION: N OUTPUT TYPE: A

No Inputs

Parameter	Description	Default	Max	Min	Code	Notes
1	MIN OUTPUT	0.00	199.99	-199.99	2	
2	MAX OUTPUT	100.00	199.99	-199.99	2	

F56 [DEV] Deviation Calculation (for Bargraph Displays)

Function **DEV** subtracts the two Inputs … Process Variable (PV) and Setpoint (SP) …, multiplies the difference by a gain, and then adds a 50% bias to the result. When used as a **PANEL** Input to control one of the front panel Bargraphs, the bargraph will be at 50% when the two signals are equal, will be > 50% when PV > SP, and will be < 50% when PV < SP.

Parameter 1 is the "Proportional Band", that is the % deviation required to drive the Output from 50% to 100%. The **DEV** formula is:

Block Output = ((PV – SP) * (50 / Parameter 1)) + 50%

DEV Examples:

PV	SP	Parm. 1	Output
52	50	2.00	100.00
50	50	2.00	50.00
48	50	2.00	0.00
73	70	5.00	80.00

```
-------------------------------------------------------------------------------------------
FUNCTION:  56          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:  12
NAME:      DEV                          SINGLE USE FUNCTION:   N        OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
Input    Type          Description                                              Notes
_____________________________________________________________________________________
  1        A       PV INPUT
  2        A       SP INPUT

Parameter          Description               Default     Max       Min        Code   Notes
_____________________________________________________________________________________
  1          % OF PV=MAX DEVIATION             2.00     50.00      0.20        2      1

Notes:
1. PV-SP error is limited to +/- 300% internally.
```

F58 [COUNT] Pulse Counter

Function **COUNT** adds 0.01% to the Block Output during the first scan that the Pulse Input changes from a 0 to a 1 (ie on the rising edge), assuming (Parameter 1) the Pulse Divisor = 1. If the Pulse Divisor = 5, then 5 pulse rising edges will have to be received before the Output is incremented by 0.01.

The Block Output rolls over from 99.99% to 0.00% after 10,000 pulses. The Block output is forced to 0.00% when the Reset Input equals 1.

A typical application would be to count flow totalizer pulses, and then connect the **COUNT** Block Output to a **PANEL** Front Panel Display channel. See **TOT** on pg 6-50.

At power down, the Block Output is saved in the Retentive Memory area of the EEPROM. During the first scan after CPU start-up, the **COUNT** Block Output is set to the value stored in the Retentive Memory.

```
-------------------------------------------------------------------------------------------
FUNCTION:  58          TEMP BYTES:   8      RETENTIVE BYTES:   4         DATA BYTES:  12
NAME:      COUNT                        SINGLE USE FUNCTION:   N        OUTPUT TYPE:   A
-------------------------------------------------------------------------------------------
Input    Type          Description                                              Notes
_____________________________________________________________________________________
  1        D       PULSE INPUT   (^1=COUNT)                                      1
  2        D       RESET INPUT   (1=RESET)

Parameter          Description               Default     Max       Min        Code   Notes
_____________________________________________________________________________________
  1          PULSE DIVISOR                       1     19999       1          2

Notes:
1. Increments Output on the rising edge of the Input
     (ie, the first scan when Input becomes a 1)
```

F59 [SQRT] Square Root

Function **SQRT** provides a 0-100% scaled square root of a 0-100% Input signal. Negative Inputs result in a 0.00% Block Output. Inputs up to +327% are acceptable. For positive Inputs the scaling formula is:

Output = 10 * (square root (Input))

Examples:
256% in = 160% out, 49% in = 70% out, 16% in = 40% out, 4% in = 20% out, 0% in = 0% out, -1% in = 0% out

FUNCTION: 59	TEMP BYTES: 0	RETENTIVE BYTES: 0	DATA BYTES: 4
NAME: SQRT		SINGLE USE FUNCTION: N	OUTPUT TYPE: A

Input	Type	Description	Notes
1	A	INPUT BLOCK	

No Parameters

F60 [ABS] Absolute Value

Function **ABS** outputs the absolute value of the Input. That is: for Input > 0, the Output = Input; for Input < 0, the Output = Input * -1.

FUNCTION: 60	TEMP BYTES: 0	RETENTIVE BYTES: 0	DATA BYTES: 4
NAME: ABS		SINGLE USE FUNCTION: N	OUTPUT TYPE: A

Input	Type	Description	Notes
1	A	INPUT	

No Parameters

F71 [PID] PID Control (with GAP and ADAPTIVE gain)

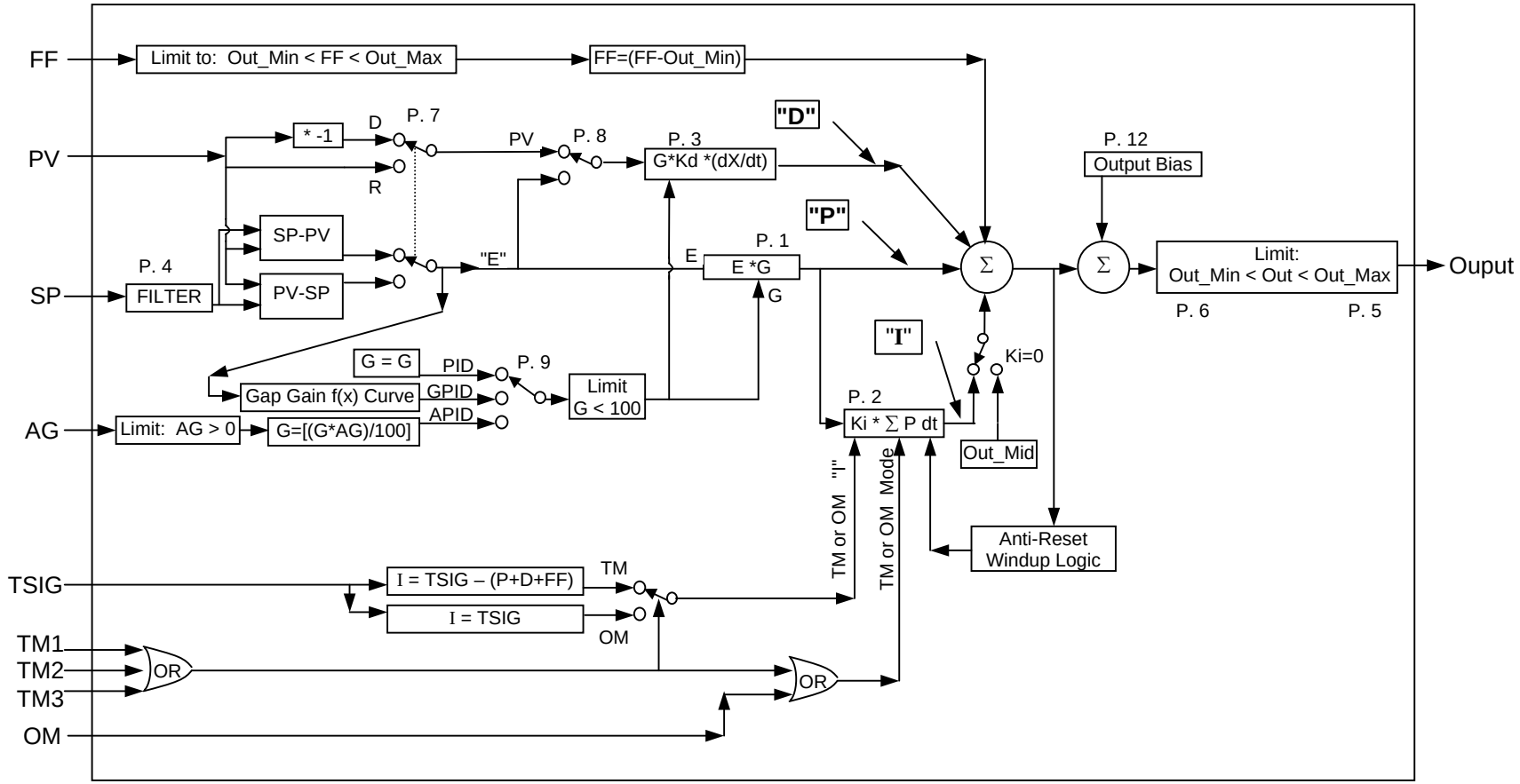
Function **PID** is a Proportional, Integral, Derivative control algorithm. The PID equation used is called the “Parallel” form by the ISA (Instrument Society of America); others have used the terms “Non-Interactive”, or “Ideal” form. See figure below for **PID** logic schematic, see Appendix *** for PID tuning suggestions.

The Proportional constant is expressed as Gain, as opposed to “Proportional Band”. To convert Proportional Band (ie “PB”) into Gain: Gain = (100 / PB) , or 5% PB is equal to a Gain of 20.00. A numerically larger Gain results in a larger **PID** output change for the same Process Variable (PV) versus Setpoint (SP) difference.

The Integral constant is expressed as “Repeats per Minute”. A numerically larger Repeats/min results in a greater **PID** output % per minute ramp change for the same Process Variable (PV) versus Setpoint (SP) difference.

The Derivative constant is expressed as “Rate Minutes”. A numerically larger Rate Minutes results in a greater **PID** output step change for the same Process Variable (PV) versus Setpoint (SP) percent per minute rate of change. The Derivative Input is low pass filtered at 1/10 of Rate Minutes to limit the Derivative Kick magnitude.

The optional Setpoint Filter (Parameter 4) can be used to reduce system upsets due to inadvertent rapid Setpoint changes by the Operator (see note 6).



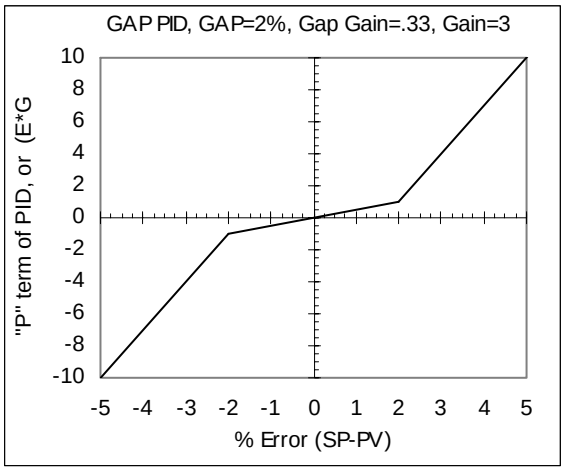
Internal Schematic of **PID** (F71) Function Block

A Feedforward Input is provided that is summed with the P+I+D values prior to the Output Min/Max limiting logic. This prevents Integral term Reset-Windup when feedforward control strategies are used.

For control logic that does not use Integral action, an Output Bias (Parameter 12) is provided to allow changing the **PID** Output mid-point (ie the Output when PV=SP), see notes 8 and 9.

Track Mode: Multiple Track Mode Inputs are provided to allow Blockware based bumpless transfer during: Manual to Auto, and Process Startup to Auto mode changes (see note 4). Track Mode causes the PID Output to be equal to the Track Signal Input by forcing the "I" (Integral) term of P + I + D. See **FPT/H** (F38) for a bumpless transfer Bockware example.

An Override Mode Input is provided to allow automatic Blockware based bumpless transfer in "Constraint" based control strategies (see note 5). Override Mode forces the "I" term to be equal to the Track Signal Input. Override Mode will not be enabled unless Repeats/min is greater than 0. An example of a Constraint based control logic is: One of several boilers on a header is burning a process off-gas …modulate the burner's firing rate based on Plant Master firing rate, unless the off-gas supply pressure drops, then reduce firing rate to maintain a minimum off-gas supply pressure.



Non-linear systems such as pH, and furnace draft can be controlled more effectively by using the Gap PID or Adaptive gain **PID** modes (Parameter 9). Gap PID provides a simple dual gain strategy (ie, lower gain near setpoint, higher gain farther away from setpoint). Adaptive gain PID allows the gain to be changed continuously as a function of a secondary variable using an **F(x)** Block (see notes 3 and 12).

FUNCTION: 71 TEMP BYTES: 44 RETENTIVE BYTES: 0 DATA BYTES: 108
NAME: PID SINGLE USE FUNCTION: N OUTPUT TYPE: A

Input	Type	Description	Notes
1	A	PV INPUT	
2	A	SP INPUT	
3	A	TRACK SIGNAL INPUT	1
4	A	FEED FORWARD INPUT	2
5	A	ADAPTIVE GAIN INPUT	3
6	D	TRACK MODE 1 INPUT (1=TRACK)	4
7	D	TRACK MODE 2 INPUT (1=TRACK)	4
8	D	TRACK MODE 3 INPUT (1=TRACK)	4
9	D	OVERRIDE MODE INPUT (1=OVERRIDE)	4

Parameter	Description	Default	Max	Min	Code	Notes
1	GAIN	10.00	100.00	0.10	2	
2	INTEGRAL, REPEATS/MIN O=OFF	1.00	60.00	0.00	2	8
3	DERIVATIVE, MINUTES 0=OFF	0.00	30.00	0.00	2	
4	SETPOINT FILTER 0=OFF, 1.00=MAX	0.00	1.00	0.00	2	6
5	MAX OUTPUT %	100.00	150.00	0.00	2	7,8
6	MIN OUTPUT %	0.00	50.00	-50.00	2	7,8
7	CONTROL ACTION 0=REV 1=DIR	0	1	0	3	10
8	DERIVATIVE ACTION 0=PV 1=ERROR	0	1	0	3	11
9	PID TYPE 1=PID,2=GPID,3=APID	1	3	1	3	3,12
10	GAP BAND (+/-% OF PV)	0.25	50.00	0.05	2	12
11	GAP GAIN MULTIPLIER	0.00	1.00	0.00	2	12
12	OUTPUT BIAS	0.00	100.00	-100.00	2	8,9

NOTES:

1. The Track Input signal is used during Track or Override modes to force the value of the PID Integral term. This Input is used to provide bumpless transfer. See above for details.
2. The Feed Forward Input is added to the result of the PID calculation before the Output Min/Max limiting logic. This prevents Integral Term Reset Windup.
3. The Adaptive gain Input is ignored for PID types 1 and 2 (see Parameter 10). Negative Input values are set equal to 0.00%, Inputs greater than +327.00% are set equal to +327.00% . The PID Gain (Parameter 1) is multiplied by the Adaptive Gain Input divided by 100.00%.
   Example: Gain = 15.0, and the Adaptive Gain Input = 25.00%, the effective PID gain would be 3.75.
4. The three Track Mode Inputs are logically OR'd together. If any one of the three Inputs equals "1", AND Repeats/Min > 0, Then: the Block Output is forced to equal the Track Signal Input. This is accomplished by forcing the PID Integral term to counteract the Proportional, Derivative, and Feed Forward terms. If all three Track Mode Inputs equal "0", the normal PID calculation determines the Output.
5. When the Override Input = "1", AND the PID is NOT in Track Mode, AND Repeats/Min > 0, the PID Integral term is set equal to the Track Signal Input. This feature is used to provide bumpless transfer when Override (i.e. Constraint) control strategies are utilized. See Example in the Configuration section. Track mode has priority over Override mode.
6. The Setpoint Filter is used to prevent abrupt PID Output changes due to setpoint changes. When the filter = 1.000, the filter time constant (in seconds) is: (60 / (Integral Repeats/Min)), Parameter 2 determines the Repeats/Min. The filtering effect is proportionately less as the Setpoint Filter parameter is reduced. Example: Setpoint Filter = 0.90, Repeats/Min = 0.75; therefore the filter time constant is 72 seconds.
   Note: If Parameter 2 = 0.01 repeats/min, and setpoint filter = 1.00, the filter time constant is 6000 seconds!
   Note: When Parameter 2 = 0.00 (i.e. Reset turned OFF), the filter time constant is 60 seconds when the setpoint filter = 1.00. Setpoint filter values less than 1.00 reduce the time constant proportionately.
   The Setpoint filter must be turned OFF for full metering combustion fuel and airflow PID loops, and for cascade control inner loops (i.e. three-element feedwater flow loop).
7. The Maximum Output limit must be greater than the Minimum Output limit (Parameters 5 and 6).
8. For P or PD modes (ie Repeats/min=0.0, I term is Off), the PID Output equals the mid-point of the Maximum and Minimum Output Parameters when PV=SP. For Example: the mid-point is 50% for 0-100% Output range, 100% for 50-150%, 75% for 50-100%, … Neither Track Mode nor Override Mode will activate if Repeats/Min = 0.0.
9. In applications when Repeats/min=0.0 (ie I term is Off), it is not always desirable for the PID Output to be at the midpoint when PV=SP (see note 8). Examples: some batch processing, level control, and pressure relief valves. Output Bias adds/subtracts to/from the standard PID midpoint Output, but the Output is still limited by the Min/Max Output Parameters. If Output Bias is non-zero when Repeats/min > 0, serious system oscillations can occur due to Reset Windup.
10. Reverse action means that the PID Output decreases when the process variable Input increases above setpoint. Direct action causes the Output to increase when the process variable increases above setpoint.
11. "Derivative Action = PV" (Parameter 10 = 0) avoids abrupt PID Output changes due to setpoint changes, since the derivative only responds to changes of the PV Input. "Derivative Action = Error" (Parameter 10 = 1) is generally only used in the inner loop of cascaded PID loops.
12. Gap PID provides an error zone on either side of the setpoint with reduced (or zero) gain. This feature is useful with noisy signals such as boiler furnace pressure, and with non-linear processes such as pH control loops. Gap Band (Parameter 11) determines setpoint deviation band within which the reduced gain is applied. The Gap Gain Multiplier (Parameter 12) numerically multiplies the normal PID Gain (Parameter 1) within the Gap Band. Gap Gain can be set equal to 0. Outside the Gap band the normal PID Gain remains the same, but the error is automatically biased down for a smooth transition (see figure above). Gap Parameters 11 and 12 are ignored for PID types 1 and 3 (see Parameter 9).

F81 [AOUT] Analog (4-20 mA) Output

Function **AOUT** is the Blockware interface to the PCC III 4-20 mA output hardware. **AOUT** converts a 0-100% Input into either a 4-20 mA output (0% = 4 mA), or a 20-4 mA output (0% = 20 mA). The **AOUT** milliamp output is proportional over the entire -25% to 125% Input range (ie 0-24 mA), and the D/A converter has 16 bit resolution (ie 0.0004 mA).

The **AOUT** Block Output is equal to the **AOUT** Block Input, unless the Block Output is "Forced" or under "Service Manual" (S/M) control (see Section 4).

When Forced, the **AOUT** Block Output is equal to the percentage that the user entered when the Block was forced. The 4-20 mA output is based on the Force Value and the “Reverse Output” parameter. Example: **AOUT** is forced to 25%, and “Reversed Output” is set to “0” or 4-20 mA; then the actual mA output would be 8 mA. If “Reversed Output” is set to “1” or 20-4 mA; then the actual mA output would be 16 mA when forced to 25%.

During Service Manual (S/M) mode, the Block Input is ignored, and the user sets the hardware mA output directly from the Front Panel (see Section 4). During S/M, the **AOUT** Block output will be the percentage that is equivalent to the mA output. If “Reverse Output” is “1”, the percentage will be scaled accordingly. Example: S/M set output to 8 mA, and “Reverse Output” is “0” (4-20); then Block Ouput will be 25%. If “Reverse Output” was “1” (20-4); then the Block Ouput would be 75%

The **AOUT** function interfaces to Analog Outputs on the CPU board, and on option boards. Parameter 1 specifies the board location, the CPU board = Board 0. Parameter 2 selects a particular Analog Output on the specified board.

FUNCTION:	**81**	**TEMP BYTES:**	**0**	**RETENTIVE BYTES:**	**0**	**DATA BYTES:**	**16**		
NAME:	**AOUT**			**SINGLE USE FUNCTION:**	**N**	**OUTPUT TYPE:**	**A**		
Input	**Type**	**Description**					**Notes**		
1	**A**	**INPUT BLOCK**							
Parameter		**Description**		**Default**	**Max**	**Min**	**Code**	**Notes**	
1		**OPTION BOARD (0=CPU BOARD)**		**0**	**2**	**0**	**3**	**1**	
2		**SELECT CH 1 OR CH 2**		**1**	**2**	**1**	**3**	**1**	
3		**REVERSE OUTPUT? 0=4-20 1=20-4**		**0**	**1**	**0**	**3**		

Notes:

1. The quantity of Outputs available is dependent on the type of option board installed. An error message is displayed during EXIT S/M if sufficient Outputs are not available.

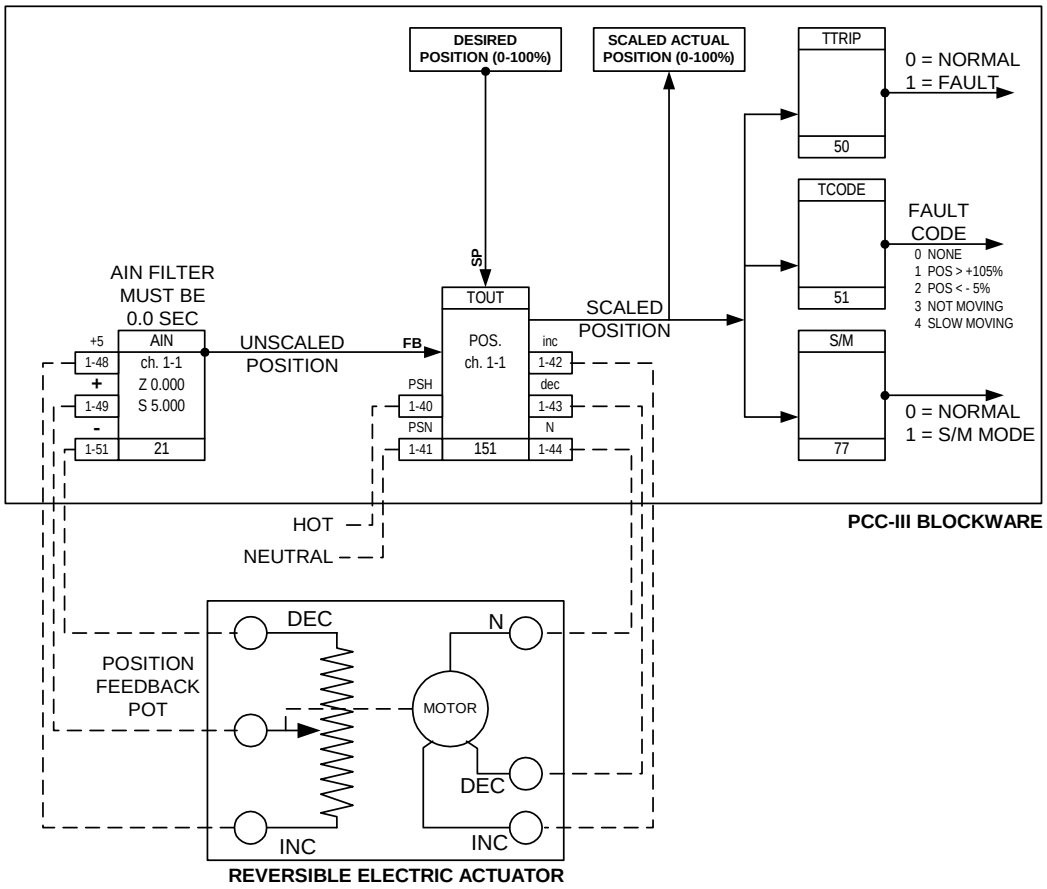
F83 [TOUT] Triac Output

(NOTE: This description is for ROM ver 3.04 or higher, See previous Manuals for earlier ROM versions**)**

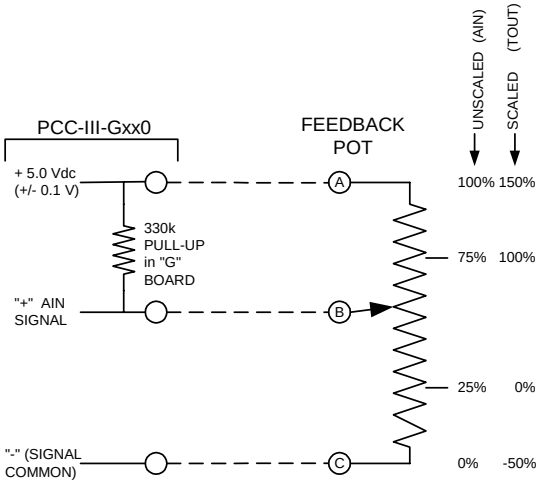
Function **TOUT** is the Blockware interface to the PCC III Triac output option board hardware. Triacs are solid state switches for use with 24-120 Vac, 0-2 Amp inductive loads. **TOUT** can be used in one of two modes: **Positioner** mode, OR **Dual Triacs** mode (see Parameter 3).

Dual Triacs Mode allows direct Blockware control of each of the individual Triacs. Triac 1 is turned on when Triac 1 Input equals 1, Triac 2 is turned on when Triac 2 Input equals 1. In Dual Triacs Mode, the Setpoint Input is ignored. The Block Output is equal to the Scaled Position as described below in Positioner mode.

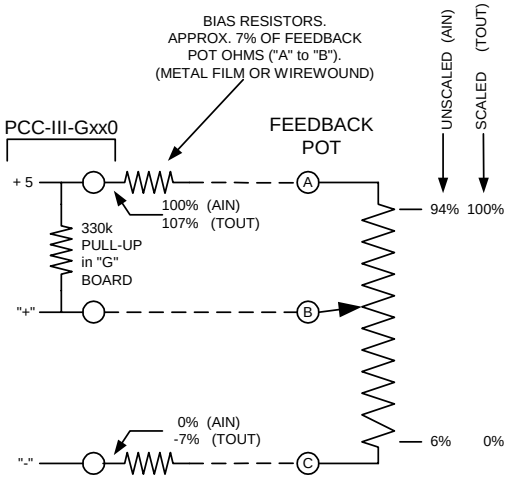
Positioner Mode is used to position a reversible electric actuator that is equipped with a position feedback signal (potentiometer, 0-5 Vdc, or 4-20 mA). **TOUT** compares the Setpoint Input to the Scaled Position, if the difference is outside of the Deadband (Parmameter. 7), one of the two Triac outputs is turned ON to drive the actuator toward the Setpoint position. When the actuator position is within the range of: (Setpoint +/- Deadband), both Triacs are turned OFF. In Positioner Mode, the Triac 1 and Triac 2 Inputs are ignored. The Block Output of **TOUT** is the 0-100% Scaled Position of the actuator. See the diagram below for a typical Positioner Mode application.



TYPICAL F83 (TOUT) 'POSITIONER' MODE APPLICATION



TYPICAL FEEDBACK POT WITH PARTIAL STROKE SETUP.
"G" BOARD INTERNAL "PULL-UP" RESISTOR USED.



FEEDBACK POT WITH FULL STROKE SETUP.
EXTERNAL "BIAS" RESISTORS FOR FAULT DETECTION.

FEEDBACK POT FAULT DETECTION WITH "PULL-UP" AND "BIAS" RESISTORS

Scaled Position (Positioner Mode): The actuator position feedback signal must be connected to a PCC-III Analog Input channel (typically on a "G" Option Board). The **AIN** Block for this channel is then connected to the **TOUT** Block Feedback Input. For Potentiometer position feedback signals, the **AIN** Block scaling Parameter values should be 0V = 0 % and 5V=100%. The **AIN** FILTER SECONDS (Parameter 6) **MUST** be set to 0.0 seconds, larger values will cause the actuator to hunt or oscillate.

TOUT Parm. 4 & 5 are used to convert the unscaled **AIN** Feedback Input to a 0-100% **TOUT** Scaled Position. Example: **AIN** = 25% at minimum position, **AIN** = 75% at maximum position. Set Parameter 4 (0% feedback) = 25%, and Parameter 5 (100% feedback) = 75%. When: Feedback Input = 25%, **TOUT** Block Output = 0%; Feedback = 35%, **TOUT** = 20%; Feedback = 45%, **TOUT** = 40%; … Feedback = 75%, **TOUT** = 100%. For '"fail open" applications P4 (Parameter 4) can be greater than P5, that is: P4 (0% feedback) = 75%, and P5 (100% feedback) = 25%.

Use S/M for Initial Actuator Setup (Positioner Mode): After the actuator electrical installation is completed, put the PCC-III into S/M mode (Service Manual, see Section 4), and exit the EDIT display mode. Then press DIS repeatedly until "TO bxcy" (Triac Output, Board x, Channel y) is displayed for the desired Triac Output channel. Press the front panel ⇑ key to open/increase the actuator, then press and hold the front panel ⇓ key to close/decrease the actuator.

Calibrating the Scaled Position (Positioner Mode): Read "Scaled Position", "Initial Actuator Setup", and "Are Bias Resistors Required" sections of **TOUT** before Calibrating. Consult the Blockware to determine the Block Number of the **TOUT** function that drives the actuator being calibrated. Use S/M mode to move the actuator during this procedure (see 'Actuator Setup' above). The Scaled Position must be calibrated whenever the actuator is initially installed, changed-out, re-stroked, or if the feedback pot is changed.

Using the "TO bxcy" S/M mode front panel display, press and hold the front panel ⇓ key until the actuator is fully closed (0% position). Use the Utilities / Examine menu (see Section 4) to display the unscaled FEEDBACK INPUT (I02) value of this **TOUT** Block. Enter this value into Parameter 4 (Feedback % at 0% Position).

Using the "TO bxcy" S/M mode front panel display, press and hold the front panel ⇑ key until the actuator is fully open (100% position). Use the Utilities / Examine menu (see Section 4) to display the un-scaled FEEDBACK INPUT (I02) value of this **TOUT** Block. Enter this value into Parameter 5 (Feedback % at 100% Position).

Deadband %, Parameter 7 (Positioner mode): This value must be adjusted individually for each actuator to minimize hunting (due to the connected load and the effectiveness of the actuator's brake). Use either "Force" mode (see Section 4) or the Blockware's "Manual" mode (if provided) to vary the actuator's position in 5-10% steps (do not use S/M mode). Then observe the actuator response. If the actuator hunts, increase the Deadband. If the actuator doesn't hunt, decrease the deadband in increments until it does hunt after a move, and then increase the deadband until the actuator doesn't hunt.

Stroke Time, Parameter 6 (Positioner mode): **TOUT** uses Parameter 6 in an anticipator calculation to minimize actuator undershoot and overshoot during each move. This parameter should be set to the approximate time (in seconds) that it takes to move the actuator from 0% to 100% (Scaled Position). Typically, 85% of the actuator nameplate stroke time is used. Values above 100% of the actual stroke time can cause overshooting and subsequent hunting. Values below 45% of the actual stroke time can cause false **TTRIP** Block trips due to "Slow Moving".

After the Deadband has been adjusted, if the actuator continues to overshoot or undershoots excessively, adjust the Stroke Time can help to reduce this. If the actuator undershoots, increase Stroke Time; if the actuator overshoots, decrease the Stroke Time.

Actuator Fault Detection (Positioner Mode): Some Hazardous applications monitor the actuators for "faults" in order to cause an alarm or safety shutdown. An example is parallel positioning of separate fuel and air actuators for burner fuel-air ratio control. **TOUT** provides internal fault monitoring logic that is made available to other Blocks via the F100 **TTRIP** and F84 **TCODE** auxiliary Output Blocks.

This logic is designed for actuators with position feedback potentiometers (pots) that are wired directly to a PCC-III analog input. This logic is NOT designed to work with 4-20 mA or other types of position feedback signals. This logic is designed to detect an open circuit in any of the Pot field wires or the Pot element, stalled or burned out motors that are not moving, and overloaded motors that are moving very slowly.

WARNING

The **TOUT** Fault Detection logic may require external Pull-up and Bias resistors for proper operation. Failure to provide these parts, and to test the installed system can result in EQUIPMENT DAMAGE, INJURY, OR DEATH.

The Fault Detection logic in **TOUT** is NOT sufficient for ALL applications. Each application must be individually assessed and the control logic and external safety shutdown systems must be individually designed for the application. Many applications require additional independent monitoring (for example: a Low Oxygen burner trip).

Typical actuator faults include: blown actuator power fuses, open field wiring, burned out motor windings, dirty feedback pots that cause the wiper to go open circuit, and worn feedback pot resistance elements that break and go open circuit.

The internal **TOUT** Fault Detection logic monitors the actuator. A Fault is indicated by a **TTRIP** Block (0=Normal, 1=Fault), and the type of Fault is indicated by a **TCODE** 0-4% analog Block output as shown below. The Inputs of the **TTRIP** and **TCODE** Blocks must be 'wired' to the **TOUT** Block Output (see figure above).

Conditions that cause **TTRIP** to change to a "1" (Fault), and the resulting **TCODE** Output:

TCODE	Condition:	Potential Reason with "Fail Closed Wiring" (+5 V wired to Pot Increase)	Potential Reason with "Fail Open Wiring" (+5 V wired to Pot Decrease)
0 %	PCC-III Reset or Power-up. No Code in Memory.		
1 %	Scaled Position greater than 105% for more than P9 seconds	Pot wiper wiring is "open circuit". Pot "-" wiring is "open circuit". Pot element is "open circuit".	Pot "+5V" wiring is "open circuit". Pot element is "open circuit".
2 %	Scaled Position less than -5% for more than P9 seconds	Pot "+5V" wiring is "open circuit". Pot element is "open circuit".	Pot wiper wiring is "open circuit". Pot "-" wiring is "open circuit". Pot element is "open circuit".
3 %	Actuator stopped moving for more than P9 seconds (Note 1).	Stalled, torque overload, jammed. Blown fuse. Any motor wire "open circuit". Motor winding burned out. Motor limit switch opened within 5-95% Scaled Position (Note 1). Check Scaled Positon calibration.	Same as "Fail Closed"
4 %	Actuator moving Slower than 40% speed for more than P9 seconds (Note 1)	Binding linkage, damper, or valve. Low AC line voltage. Stroke Time (P6) set too low.	Same as "Fail Closed"

Note 1: TTRIP will NOT "Fault" due to "Actuator Stopped" or "Actuator Slow" if any of the following are true:

The TOUT channel is in S/M mode.
Scaled Position is less than -5% or greater than 105%.
The Decrease Triac is ON, and the Scaled Position is less than 5%
The Increase Triac is ON, and the Scaled Position is greater than 95%
(The last two prevent nuisance 'Faults' due to inaccurate travel limit switch operation)

All actuators that use Fault Detection require a "pull-up" resistor (330k or less) that is connected from the Feedback Pot wiper to +5V, and it should be located inside the PCC-III controller. Review "Pull-Up/Down Resistor for Voltage Inputs" in Section 2. If the pot wiper circuit field wiring goes open circuit, or if the wiper loses contact with the pot element due to wear or dirt, the PCC-III analog input will ramp to +5V within 3 seconds or less. The PCC-III "G" option board includes an internal 330k pull-up resistor for each analog input. The CPU, "A", "B", and "F" board analog inputs do NOT have internal pull-up resistors, and require external resistors.

Are Bias Resistors Required for Positioner mode Fault Detection?: If 0V and +5V position feedback pot voltages correspond to a Scaled Position outside the -5% to +105% range, Bias resistors are NOT required. If 0V and +5V correspond to a Scaled Position inside the -5% to +105% range, Bias resistors ARE required. Preferred Instruments model DM-1E-P1 actuators (90 deg stroke) do NOT require Bias resistors, Preferred model R-AL actuators DO require 75 ohm Bias resistors.

The best way to determine if Bias resistors are required with other actuators is to install the actuator, stroke it, Calibrate the Scaled Position (see above), and then test the actuator for proper Fault Detection (see below for procedure). When in doubt, install Bias Resistors (if Fault Detection is required)..

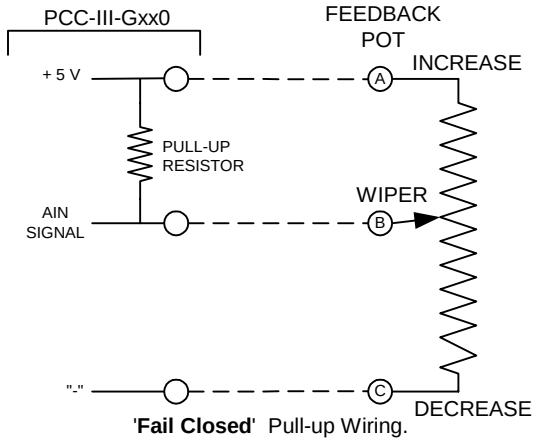
See the schematic above for Bias resistor wiring. Use metal film or wirewound Bias Resistors (for low temperature drift), carbon composition or carbon film resistors should be not be used if the ambient temperature changes substantially. The Bias resistance should be approximately 7% (or more) of the feedback pot element's actual resistance (some pots have a +/- 20% tolerance).

Fail Mode: STOP, INC, DEC, DISABLE (Parameter 8): If the Scaled Position is outside the -5% to +105% range for more than P9 seconds, TOUT activates the triacs according to the mode selected by P8:

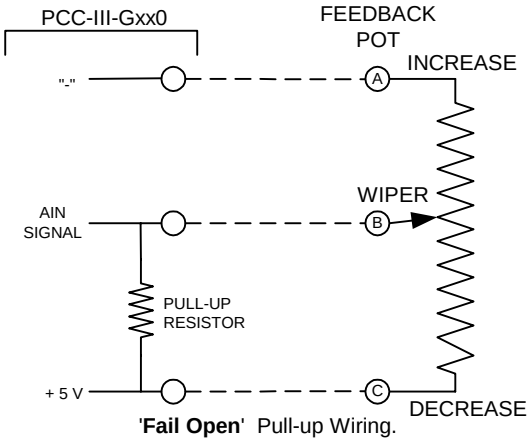
P8	Fail Mode	Triac Response
0	STOP	Both triacs are turned OFF.
1	INC	INCREASE triac is turned ON, DECREASE triac is turned OFF
2	DEC	DECREASE triac is turned ON, INCREASE triac is turned OFF
3	DISABLE	The Fault is ignored. The triacs respond to the normal **TOUT** PV and SP logic

During the P9 time delay, the triacs respond to the normal **TOUT** PV and SP logic. Wire the Feedback Pot as indicated below to achieve the desired response during the P9 time delay:

Desired Response:	Connect Pot "Increase" end to:	Connect Pot "Decrease" end to:
Fail Close	+5 V	"-" (Signal Common)
Fail Open	"-" (Signal Common)	+5 V



'**Fail Closed**' Pull-up Wiring.
If Wiper Opens:
AIN = +5V (> 100%), Decrease Triac turns ON



'**Fail Open**' Pull-up Wiring.
If Wiper Opens:
AIN = +5V (< 0%), Increase Triac turns ON

"PULL-UP" WIRING FOR "FAIL-CLOSED" AND "FAIL-OPEN" SYSTEMS

Test Feedback Pot Fault Detection: Install the actuator, stroke it, Calibrate the Scaled Position (see above), and then test the Feedback Pot Fault Detection. The block outputs of TOUT, TTRIP, and TCODE must be monitored during the test. Frequently these are Front Panel Display channels; if not, consult the Blockware drawing to find the block numbers and use the Utilities / Examine menu (see Section 4) to display the values.

Disconnect one feedback pot wire at a time, leaving the other two wires connected. Verify the following:

Open Pot Wire	TOUT for "Fail Closed Wiring" (+5 V = Increase)	TCODE for "Fail Closed Wiring" (+5 V = Increase)	TOUT for "Fail Open Wiring" (+5 V = Decrease)	TCODE for "Fail Open Wiring" (+5 V = Decrease)
Increase	less than -5%	2.00 %	less than -5%	2.00 %
Wiper	greater than +105%	1.00 %	less than -5%	2.00 %
Decrease	greater than +105%	1.00 %	greater than +105%	1.00 %

"Forcing" **TOUT** Blocks (see Section 4):
Positioner mode: The "Forced" Block Output becomes the Setpoint, and the Setpoint Input signal is ignored. That is, when Forced, triacs activate based on the Scaled Feedback as compared to the Forced Block Output. TOUT uses the normal Positioner logic when "Forced", and therefore requires the Position Feedback Input to be active and Scaling Parameters 4 & 5 to be setup for proper operation.

Dual Triacs mode: +199.99% activates Triac 1, -199.99% activates Triac 2.

S/M Mode, Dual Triacs mode (See Section 4): Using the "TO bxcy" S/M mode front panel display, pressing the ⇑ key will activate Triac 1 (Increase) for as long as the ⇑ key is depressed. The ⇓ key similarly activates Triac 2 (Decrease).

FUNCTION: 83 TEMP BYTES: 0 RETENTIVE BYTES: 0 DATA BYTES: 52
NAME: TOUT SINGLE USE FUNCTION: N OUTPUT TYPE: A

Input	Type	Description	Notes
1	A	SETPOINT INPUT	1,8
2	A	FEEDBACK INPUT	
3	D	TRIAC 1 INPUT (INCREASE)	2
4	D	TRIAC 2 INPUT (DECREASE)	2

Parameter	Description	Default	Max	Min	Code	Notes
1	OPTION BOARD (1-3)	3	3	1	3	7
2	TRIAC PAIR	1	2	1	3	3,7
3	MODE 0=POSITIONER 1=DUAL TRIACS	0	1	0	3	
4	FEEDBACK % AT 0% POSITION	0.0	150.0	-50.0	3	4,5
5	FEEDBACK % AT 100% POSITION	100.0	250.0	-50.0	3	4,5
6	STROKE TIME (SEC)	15.0	300.0	4.0	3	6
7	DEADBAND %	0.7	15.0	0.1	3	
8	FAIL MODE: 0=STOP 1=INC 2=DEC 3=DISABLE	3	3	0	3	
9	FAIL TRIP DELAY	3.0	90.0	2.0	3	

Notes:
1. Ignored in Dual Triac mode.
2. Ignored in Positioner mode.
3. The "G" option board has two pairs of Triacs.
4. The difference between Parameters 4 & 5 must be greater or equal to 10%.
5. Reverse Input scaling is valid, i.e. 0% POSITION = 100% Feedback, 100% POSITION = 0% Feedback.
6. Stroke time is from 0% to 100% POSITION (ie Scaled Feedback, NOT 0-100% Feedback Input).
7. The quantity of Outputs available is dependent on the type of option board installed. An error message is displayed during EXIT S/M if sufficient Outputs are not available.
8. Internally limited to 0-100% range.

F84 [TCODE] TOUT Fault Code

Function **TCODE** indicates the Fault code of a particular **TOUT** Block. The **TCODE** Block Output = 0%, 1%, 2%, 3% or 4%. See F83 **TOUT** for details on the Fault Detection logic and descriptions of the Codes in the **TOUT** block that drives the **TCODE** Block output. The analog Input to the **TCODE** Block is a dummy Input that is used to indicate which **TOUT** Output Block is to be monitored.

TCODE outputs the last Fault Code that occurred and the Code will not change until a different Fault occurs. The Code resets to 0% when PCC-III powers-down.

FUNCTION:	84	TEMP BYTES:	0	RETENTIVE BYTES:	0	DATA BYTES:	4
NAME:	TCODE			SINGLE USE FUNCTION:	N	OUTPUT TYPE:	A

Input	Type	Description	Notes
1	A	TOUT BLOCK TO BE MONITORED	1

No Parameters

Notes:
1. The BLOCK TO BE MONITORED must be a TOUT Block.

F90 [D0] Discrete 0 Constant

Function **D0** provides a constant Output of a discrete 0 (ie logic “Low”).

PCC III automatically configures Block 2 to be function **D0 .** Block 2 (discrete 0) is the default Input for all discrete Inputs for all functions. Block 2 cannot be changed to any other function. However, other Blocks may be configured as **D0 .** No Inputs or parameters are required for **D0** .

FUNCTION:	90	TEMP BYTES:	0	RETENTIVE BYTES:	0	DATA BYTES:	0
NAME:	D0			SINGLE USE FUNCTION:	N	OUTPUT TYPE:	D

No Inputs and No Parameters

F91 [D1] Discrete 1 Constant

Function **D1** provides a constant Output of a discrete 1 (ie logic “High”).

PCC III automatically configures Block 3 to be function **D1 .** Block 3 (discrete 1) is useful as a dummy Input to many other functions: **PANEL, LOGIC**, … . Block 3 can not be changed to any other function. However, other Blocks may be configured as **D1 .** No Inputs or parameters are required for **D1** .

FUNCTION:	91	TEMP BYTES:	0	RETENTIVE BYTES:	0	DATA BYTES:	0
NAME:	D1			SINGLE USE FUNCTION:	N	OUTPUT TYPE:	D

No Inputs and No Parameters

F92 [DIN] Discrete Input

Function **DIN** is the Blockware interface to the PCC III 120 Vac optically isolated Discrete Inputs hardware. The **DIN** function interfaces to Discrete Inputs on the CPU board, and on option boards. Parameter 1 specifies the board location, the CPU board = board 0. Parameter 2 selects a particular Discrete Input on the specified board.

When 120 Vac is applied to the selected Input, the Block Output equals discrete "1". Optionally, Parameter 3 (Invert Output) can be used to invert the Output (ie, 120 Vac Input equals discrete "0" Output)

```
-------------------------------------------------------------------------------------------
FUNCTION:  92          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:  12
NAME:      DIN                         SINGLE USE FUNCTION:   N        OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
No Inputs

Parameter          Description               Default     Max       Min        Code   Notes
_____________________________________________________________________________________________
  1           OPTION BOARD (0=CPU BOARD)        0         2         0          3
  2           INPUT CHANNEL                     1         5         1          3      1
  3           INVERT OUTPUT? 0=NO 1=YES         0         1         0          2
Notes:
1. Maximum quantity depends on type of option board that is currently installed
```

F93 [DCON] Discrete Constant

Function **CON** outputs a user defined discrete constant. This value can be changed via: the PCC III Editor menus (under password protection), via RS232 Blockware download, or via the RS485 communications link (using **PLINK** F124). This value cannot be changed from the PCC III front panel Operator displays during normal operation.

```
-------------------------------------------------------------------------------------------
FUNCTION:  93          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:   4
NAME:      DCON                        SINGLE USE FUNCTION:   N        OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type          Description                                          Notes
_____________________________________________________________________________________________
                       NONE

Parameter          Description               Default     Max       Min        Code   Notes
_____________________________________________________________________________________________
  1           DISCRETE CONSTANT VALUE           0         1         0          2
```

F95 [S/M] Service Manual Status

Function **S/M** indicates the current Service Manual (S/M) status of a particular **AOUT** or **TOUT** Block. The **S/M** Block Output = 1 if the monitored **AOUT** or **TOUT** Block is in S/M mode. The analog Input to the **S/M** Block is a dummy Input that is used to indicate which **AOUT** or **TOUT** Output Block is to be monitored.

This Block is primarily used to activate FPT/H and PID Track Mode when a loop is in S/M mode. This can provide bumpless transfer when exiting S/M mode.

```
-------------------------------------------------------------------------------------------
FUNCTION:  95          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:   4
NAME:      S/M                         SINGLE USE FUNCTION:   N        OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type          Description                                          Notes
_____________________________________________________________________________________________
  1        A       BLOCK TO BE MONITORED                                     1

No Parameters
Notes:
1. The BLOCK TO BE MONITORED must be an AOUT or TOUT Block.
```

F96 [PANEL] Front Panel Display

Function **PANEL** is the Operator's interface to the PCC III Blockware logic. The Blockware designer uses **PANEL** to determine the Blockware variables that the Operator can view, the variables the Operator can modify, and the alarms to be annunciated. The **PANEL** Block Output is controlled by the "Annunciator Logic" (see below). "[x]" refers to the items called out on the front panel drawing.

PANEL controls the front panel Bargraphs [9] [10] [11], the 4 ½ digit Numeric display [1], the 8 character alphanumeric Message display [2], the Alarm LED [5], and **PANEL**'s "Alarm Horn" Block Output. **PANEL** responds to the front panel pushbuttons ACK [3] (ACKnowledge), DIS [4] (DISplay channel select), ⇑, ⇓ [6], and optionally, the AUTO/MAN key(s) [7]. **PANEL** can be configured for one loop or multiple loops. See Section 3 for details on how to operate the front panel display control pushbuttons, and for further details on the annunciator.

The front panel Numeric and Message displays have three operating modes: **Edit**, **Process**, and **Annunciator**.

Edit mode
Edit mode has priority over Process and Annunciator modes, and overrides the **PANEL**'s control of the Numeric and Message displays. Edit mode is active when the "ESC/EDIT" LED [8] (behind the lower front door) is ON (see Section 4, Edit Menus). To exit Edit mode, and return to Process mode, press the ESC/EDIT key [8] several times until the "ESC/EDIT" LED [8] turns OFF.

Process mode
Process mode allows the Operator to view any of the 10 configured display channels. Each channel has an Input (Inputs 1-10) to determine the Block Output that drives the display channel. Each channel also has 4 Parameters (Parameters 2-41) for formatting the displayed value: Fixed Decimal Point Location, Zero (0%) Input Display Scaling, Span (100%) Input Display Scaling, and a Channel Descriptor Message (16 characters max., A-Z, 0-9, and symbols). See "Display Channel Scaling Examples" below. Messages can be entered or edited from the Edit Menus, or via RS232 download.

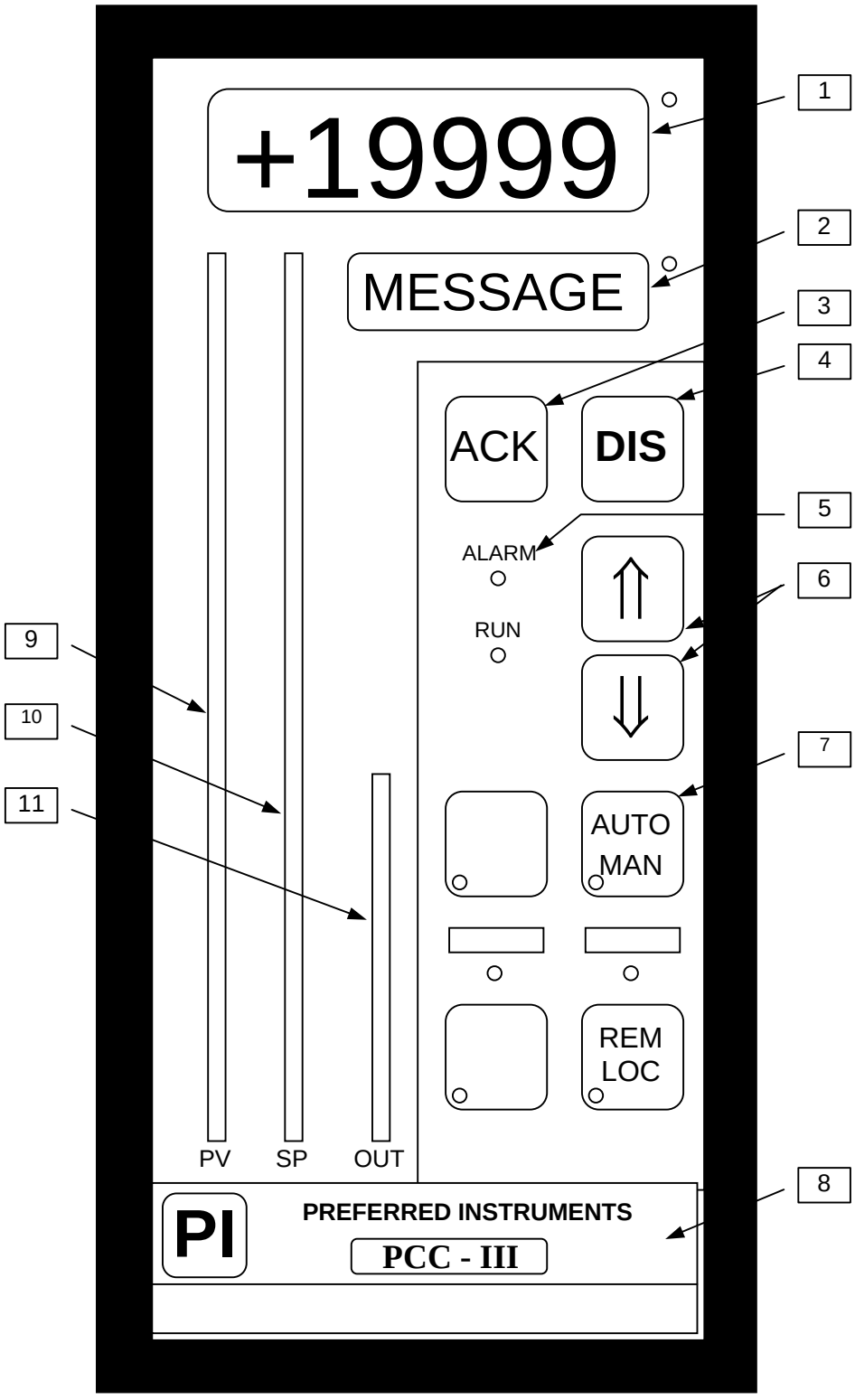
PANEL also allows the Operator to modify **FPCON** (F55) and **FPT/H** (F38) Block Outputs using the front panel ⇑, and ⇓ keys [6]. Typically, this is used for Operator adjustment of: Setpoints, Ratios, Valve and Damper positions, and other values. **PANEL** bi-directionally translates between the displayed scaled value and the **FPCON** or **FPT/H** Block's % Output based on the scaling Parameters of the channel. **PANEL** limits the Operator's adjustment range to the scaled range determined by the MIN and MAX % Output Parameters in each **FPCON** and **FPT/H** Block. **PANEL** will not allow Operator adjustment of a **FPT/H** Block unless it is in Hold mode (See F38 **FPT/H**).

The scaled Numeric value and the Channel Descriptor Message are always displayed as a matched pair. Pressing the DIS key [4] selects the next display channel. DIS wraps around to the first channel after the last active channel is displayed.

Optionally, a more powerful, Operator-friendly, automatic display channel selector system (Auto DIS) is available. Auto DIS can automatically display the Process Variable when the Operator puts the loop in Auto, and the Valve/Damper when the Loop is put into Manual. Auto DIS can also coordinate the displays of a dual loop controller. However, the DIS key [4] can still be used to manually select a display channel when Auto DIS is utilized. See "Automatic Display Channel Selection" below for details.

Annunciator mode
Annunciator mode allows the Operator to view up to 10 user defined alarm messages (16 characters max., each) stored in a sequential, first-out memory stack. Alarms are saved in the order that the alarms occurred, and are displayed oldest alarm first, most recent alarm last. Press the ACK [3] key to activate Annunciator mode and view the first alarm message. Once activated press ACK [3] repeatedly to view additional alarm messages. Press DIS [4] to leave Annunciator mode and return to Process mode.

The Message display shows the alarm message as entered in Parameters 42-51. The Numeric display shows the sequential position of the alarm. Example: " 1 3", means "first of three" alarms stored in the stack (ie the oldest). See "Annunciator Logic" below for further details.


+19999
MESSAGE
ACK
DIS
ALARM
RUN
AUTO
MAN
REM
LOC
PV
SP
OUT
PI
PREFERRED INSTRUMENTS
PCC - III
1
2
3
4
5
6
7
8
9
10
11

Bargraph Control: All three bargraphs … PV [9] or left, SP [10] or middle, and OUT [11] or right … turn ON one LED when it's Input is 0%, turn ON all LED's when it's Input is 100%, and a proportional quantity between 0 and 100%. A **SCALE** or **DEV** Block can be used to convert non 0-100% Block Outputs to 0-100% bargraph Inputs.

Inputs 11-13 control the bargraphs when Input 19 (Loop 2) = "0"; and Inputs 15-17 control the bargraphs when Input 19 (Loop 2) = "1".

Display Channel Scaling Examples:

Block Output %	Calibration	Desired Display Format		DEC PT.	ZERO (Display for Input = 0%)	SPAN (Display for Input = 100%)
0-100 %	0-200 psig	0-200		0	0	200
0-100 %	0-200 psig	0.0-200.0		1	0.0	200.0
100-0%	0-30 " level	0.0-30.0		1	30.0	0.0
0-100%	-15" to +15" level	-15.0 - +15.0		1	-15.0	15.0
80-120%	.80 to 1.20 ratio	0.80 to 1.20		2	0.00	1.00
0-100%	800-1200 psig	800-1200		0	800	1200
0-100%	0-70 klb/hr	0.00-70.00		2	0.00	70.00

Automatic Display Channel Selection (Auto DIS): If Inputs 14 (A/M PB 1), and 19 (Loop 2 Sel.) are left at the default of Block 2 (D0), then the DIS key [4] is the only method to change the selected display channel. If Inputs 1-6, 14, 18, and 19 are configured as shown, the display will jump to the Process Variable when entering AUTO, and will jump to the Controller Output (ie Valve/Damper **FPT/H**) when entering Manual. If dual Loops are configured, the display jumps to the selected Loop when the Loop2 Input changes.

The descriptions of Inputs 1-6, "OUT 1, PV 1, …" are provided to assist in configuring **PANEL** for Auto DIS. However, any variable can be assigned to any display channel.

Recommended **PANEL** Inputs configuration for:

Single Loop "Auto DIS" display control:

AUTO/MAN 1 (0=AUTO, 1=MAN) Input 14	CHANNEL DISPLAYED (and Input Number)
^MAN	1 (OUT 1)
^AUTO	2 (PV 1)

NOTES: Input 19 = Block 2 (D0), ie Loop2=0.
^MAN means: on the rising edge of MAN
(i.e., only once during the scan that the Input changes to MAN)

Dual Loop "Auto DIS" display control:

LOOP 2 SELECT (0=Loop1, 1=Loop2) Input 19	AUTO/MAN 1 (0=AUTO, 1=MAN) Input 14	AUTO/MAN 2 (0=AUTO, 1=MAN) Input 18	CHANNEL DISPLAYED (and Input Number)
LOOP 1	^MAN	X	1 (OUT 1)
LOOP 1	^AUTO	X	2 (PV 1)
LOOP 2	X	^MAN	4 (OUT 2)
LOOP 2	X	^AUTO	5 (PV 2)
^LOOP 1	MAN	X	1 (OUT 1)
^LOOP 1	AUTO	X	2 (PV 1)
^LOOP 2	X	MAN	4 (OUT 2)
^LOOP 2	X	AUTO	5 (PV 2)

NOTES: **^MAN** means: on the rising edge of MAN
(i.e., only once during the scan that the Input changes to MAN)
X means: This Input is ignored.

Typical **PANEL** Input Descriptions:
OUT x: The FPT/H Block that drives the controller **AOUT** or **TOUT** Output

PV x: The **AIN** or other Math Block being used as the Process Variable for this Loop
SP x: The **FPCON**, or **FPT/H** Block that generates the Loop Setpoint (PID loops only)
AUTO/MAN x: The **PB** Block that the Operator uses to select the Auto / Manual mode
LOOP2: The **PB**, **DIN**, or other Block that the Operator uses to Select which Loop to view.

Annunciator Logic: Inputs 20-29 determine which Blocks will be annunciated. The first scan that an alarm Input changes from a "0" to a "1" (ie, on the rising edge), the matching alarm channel message is stored at the end of the sequential memory stack. If an alarm clears and re-alarms before the alarm message is viewed (ie acknowledged), **PANEL** will NOT put a second copy of the same message on the stack.

When Input 31 (Annunciator Enable) equals "1", the annunciator functions normally. When the Annunciator Enable Input equal "0" (the default Input), no new alarms are stored in the stack. However, all existing alarms on the stack remain until cleared and acknowledged. Annunciator Enable can be used to prevent nuisance alarms during process startup or shutdown.

When a new alarm occurs, the **PANEL** Block Output changes to a "1", The ALARM LED [5] starts flashing, and optionally (see Parameter 1) the bargraphs start flashing. Typically, the **PANEL** Block Output is connected to a **ROUT**, **DOUT**, or **TOUT** Block, and then physically wired to an external audible alarm. To silence an alarm, Press ACK, or change Input 30 (Remote Alarm Silence) from a "0" to a "1" to change **PANEL**'s Block Output back to "0", and to stop the optional bargraph flashing. See Section 3 for further details.

Note: If there are multiple PCC III's, all of the configured alarm horn outputs can be wired in parallel to a single audible alarm. A single external Alarm Silence pushbutton can then be wired in parallel to a **DIN** on each PCC III.

FUNCTION: 96	TEMP BYTES: 0	RETENTIVE BYTES: 0	DATA BYTES: 328
NAME: PANEL		SINGLE USE FUNCTION: Y	OUTPUT TYPE: D

Input	Type	Description	Notes
1	A	DIS CH 1 <OUT 1>	4
2	A	DIS CH 2 <PV 1>	4
3	A	DIS CH 3 <SP 1>	4
4	A	DIS CH 4 <OUT 2>	4
5	A	DIS CH 5 <PV 2>	4
6	A	DIS CH 6 <SP 2>	4
7	A	DIS CH 7	
8	A	DIS CH 8	
9	A	DIS CH 9	
10	A	DIS CH 10	
11	A	PV BARGRAPH 1	2
12	A	SP BARGRAPH 1	2
13	A	OUT BARGRAPH 1	2
14	D	AUTO/MAN PB 1 (OPTIONAL, 0=AUTO, 1=MAN)	4
15	A	PV BARGRAPH 2	2
16	A	SP BARGRAPH 2	2
17	A	OUT BARGRAPH 2	2
18	D	AUTO/MAN PB 2 (OPTIONAL, 0=AUTO, 1=MAN)	4
19	D	LOOP 2 SELECT (OPTIONAL, 0=LOOP 1, 1=LOOP 2)	4
20	D	ALM CH 1	1
21	D	ALM CH 2	1
22	D	ALM CH 3	1
23	D	ALM CH 4	1
24	D	ALM CH 5	1
25	D	ALM CH 6	1
26	D	ALM CH 7	1
27	D	ALM CH 8	1
28	D	ALM CH 9	1
29	D	ALM CH 10	1
30	D	RMT ALM SILENCE BLOCK	1
31	D	ANNUCIATOR ENABLE BLOCK	1

Parameter	Description	Default	Max	Min	Code	Notes
1	BARGRAPH FLASH 0=NO 1=YES	1	1	0	2	1
2	CH 1 DEC PT	0	4	0	2	3
3	CH 1 ZERO	0	19999	-19999	2	3
4	CH 1 SPAN	100	19999	-19999	2	3
5	CH 1 MESSAGE	CH 1			2	5
6	CH 2 DEC PT	0	4	0	2	3
7	CH 2 ZERO	0	19999	-19999	2	3
8	CH 2 SPAN	100	19999	-19999	2	3
9	CH 2 MESSAGE	CH 2			2	5
10	CH 3 DEC PT	0	4	0	2	3
11	CH 3 ZERO	0	19999	-19999	2	3
12	CH 3 SPAN	100	19999	-19999	2	3
13	CH 3 MESSAGE	CH 3			2	5
14	CH 4 DEC PT	0	4	0	2	3
15	CH 4 ZERO	0	19999	-19999	2	3
16	CH 4 SPAN	100	19999	-19999	2	3
17	CH 4 MESSAGE	CH 4			2	5
18	CH 5 DEC PT	0	4	0	2	3
19	CH 5 ZERO	0	19999	-19999	2	3
20	CH 5 SPAN	100	19999	-19999	2	3
21	CH 5 MESSAGE	CH 5			2	5
22	CH 6 DEC PT	0	4	0	2	3
23	CH 6 ZERO	0	19999	-19999	2	3
24	CH 6 SPAN	100	19999	-19999	2	3
25	CH 6 MESSAGE	CH 6			2	5
26	CH 7 DEC PT	0	4	0	2	3
27	CH 7 ZERO	0	19999	-19999	2	3
28	CH 7 SPAN	100	19999	-19999	2	3
29	CH 7 MESSAGE	CH 7			2	5
30	CH 8 DEC PT	0	4	0	2	3
31	CH 8 ZERO	0	19999	-19999	2	3
32	CH 8 SPAN	100	19999	-19999	2	3
33	CH 8 MESSAGE	CH 8			2	5
34	CH 9 DEC PT	0	4	0	2	3
35	CH 9 ZERO	0	19999	-19999	2	3
36	CH 9 SPAN	100	19999	-19999	2	3
37	CH 9 MESSAGE	CH 9			2	5
38	CH 10 DEC PT	0	4	0	2	3
39	CH 10 ZERO	0	19999	-19999	2	3
40	CH 10 SPAN	100	19999	-19999	2	3
41	CH 10 MESSAGE	CH 10			2	5
42	ALM CH 1 MESSAGE	ALM 1			2	5
43	ALM CH 2 MESSAGE	ALM 2			2	5
44	ALM CH 3 MESSAGE	ALM 3			2	5
45	ALM CH 4 MESSAGE	ALM 4			2	5
46	ALM CH 5 MESSAGE	ALM 5			2	5
47	ALM CH 6 MESSAGE	ALM 6			2	5
48	ALM CH 7 MESSAGE	ALM 7			2	5
49	ALM CH 8 MESSAGE	ALM 8			2	5
50	ALM CH 9 MESSAGE	ALM 9			2	5
51	ALM CH 10 MESSAGE	ALM 10			2	5

Notes:

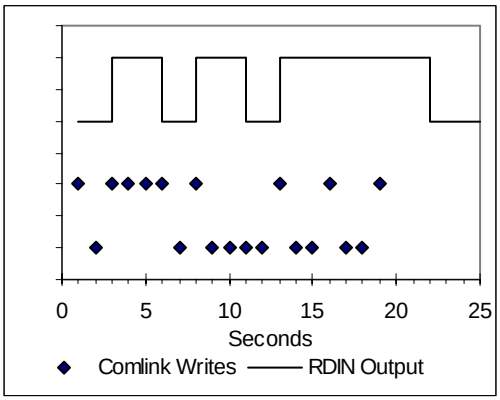
1. See "Annunciator Mode" and "Annunciator Logic" above.
2. See "Bargraph Control" above.
3. See "Display Scaling Examples" above.
4. See "Automatic Display Channel Selection" above.
5. See Section 4. When modifying from Edit Menus: DIS moves cursor right; EDIT▲ & EDIT▼ change the character at the blinking cursor.

F97 [RDIN] (RS485) Remote Discrete Input

When the PCC III RS485 communications link (Comm Link) is in "Local Mode", the Comm Link can read all Block Outputs; however, the Comm Link is prevented from writing data to (ie changing) all Block Outputs, with the exception of the **RAIN** and **RDIN** Blocks. The Comm Link is permitted to write data to **RAIN** and **RDIN** Block Outputs at all times.

Pulse Mode = Off (ie Parameter 1 = 3600 sec): The value written by Comm Link remains in effect until a new value is written by Comm Link, or until a Comm Link time-out. Upon Comm Link time-out (ie no new Comm Link writes within (Parameter 2) seconds), the Comm Link value can either remain at the last value received or switch to the default value (see parameters 3 & 4).

Pulse Mode = On (ie Parameter 1 < 3600 sec): The **RDIN** Block Output becomes a re-triggerable one-shot pulse, with (Parameter 1) seconds minimum duration. If Parameter 1 = 0 seconds, **RDIN** creates a one scan long pulse. Pulse mode is useful as a Comm Link Watchdog timer, or for logic that requires momentary pulses.



A Comm Link write of "0" followed by a Comm Link write of "1" is the "trigger" to change the **RDIN** Output to a "1" and start the Pulse timer. If no additional Comm Link triggers occur, the **RDIN** Output changes to a "0" after the Pulse timer expires. If another Comm Link trigger occurs when **RDIN**'s Output = "1", the timer restarts. If no further Comm Link writes occur, or if Comm Link continuously writes either a "1" or a "0", the Pulse timer will expire, and the **RDIN** output changes back to a "0". See Pulse Mode timing diagram below:

Power Down: The Block Output is saved in the Retentive Memory area of the EEPROM.

CPU start-up: If Pulse Mode=Off: The Block Output and the Comm Link value are set to the value in Retentive Memory during the first scan. If Retentive Memory is invalid, the Block Output initializes to the Default Output upon CPU start-up. If Pulse Mode=On: The Block output is set to "0", and Comm Link must write a "0", followed by a "1" to change the **RDIN** Output to a "1".

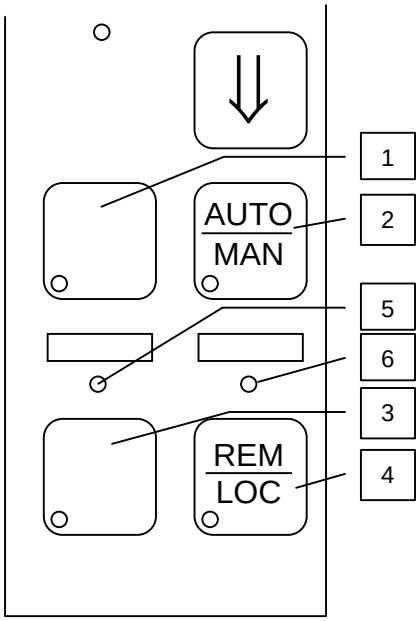
FUNCTION: 97 TEMP BYTES: 4 RETENTIVE BYTES: 1 DATA BYTES: 16
NAME: RDIN SINGLE USE FUNCTION: N OUTPUT TYPE: D

No Inputs

Parameter	Description	Default	Max	Min	Code	Notes
1	PULSE SECONDS (3600=CONTINUOUS)	3600	3600	0	2	1
2	COMM FAIL DELAY SEC.	5	3600	1	2	x
3	FAIL ACTION 0=LAST, 1=DEFAULT	0	1	0	2	x
4	FAIL DEFAULT	0	1	0	2	x

Notes:
1. If Pulse Seconds less than 3600, Fail delay must be greater than Pulse seconds.

F98 [PB] Pushbutton



Function **PB** is the Blockware interface to the 4 user configurable pushbuttons on the front panel. Each pushbutton has an LED indicator that is controlled separately by an **LED** (F99) Block. Parameter 1 selects the pushbutton (see adjacent figure for locations).

The AUTO/MAN, and REM/LOC pushbuttons are permanently labeled. Pushbuttons 1 and 3 can be labeled by the user by sliding a clear plastic legend in behind the keyboard (see Section 8 for details). Legends can be made by with a word processor, clear plastic overhead transparency material, and a laser printer.

Parameter 2 specifies how the **PB** Block Output responds when the Operator presses a pushbutton. “MOM HI” (Momentary High) means the Output = “1” for as long as the button is depressed, and returns to a “0” when released. “MOM LO” (Momentary Low) is the opposite of MOM HI (not pressed = “1”, depressed = “0”). “TOGGLE” means that the Output changes to the opposite of the previous Block Output during the first scan of every new button press.

At power down, the **PB** Block Output is saved in the Retentive Memory area of the EEPROM. During the first scan after CPU start-up, the **PB** Block Output is set according to Parameter 3. “LAST” means: use the value saved in Retentive Memory.

FUNCTION: 98 TEMP BYTES: 0 RETENTIVE BYTES: 1 DATA BYTES: 12
NAME: PB SINGLE USE FUNCTION: N OUTPUT TYPE: D

Input	Type	Description	Notes
		NONE	

Parameter	Description	Default	Max	Min	Code	Notes
1	SELECT 1=TOP 2=A/M 3=BOT 4=R/L	1	4	1	3	1
2	TYPE 1=MOM HI 2=MOM LO 3=TOGGLE	3	3	1	2	1
3	POWER UP 1=HI 2=LO 3=LAST	3	3	1	2	1

Notes:
1. See the description above.

F99 [LED] LED

Function **LED** is the Blockware interface to the 6 user configurable LED indicators on the front panel. The LED's located on the pushbuttons are controlled separately by function **LED**. Function **PB** does not control these LED's directly. However; in many applications, a **PB** Block Output is used as the Input to the mating **LED** Block.

Parameter 1 selects the LED to be used … see the figure in **PB** (F98) for locations. By default, the LED is On when the Input = "1", and the LED Block Output = the Block Input. Parameter 2 allows the LED and **LED** Block Outputs to be inverted.

```
-------------------------------------------------------------------------------------------
FUNCTION:  99          TEMP BYTES:   0     RETENTIVE BYTES:   0        DATA BYTES:  12
NAME:      LED                       SINGLE USE FUNCTION:   N       OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type          Description                                            Notes
_____________________________________________________________________________________
  1        D       INPUT BLOCK                                                1

Parameter          Description                Default     Max       Min       Code   Notes
_____________________________________________________________________________________
  1           SELECT (1 THRU 6)                  1         6         1         2      2
  2           INVERT INPUT? 0=NO 1=YES           0         1         0         2      1

Notes:
1.   If Parm. 2 (INVERT INPUT) = 0: When Input = 1, LED is On, Output = 1
     If Parm. 2 (INVERT INPUT) = 1: When Input = 1, LED is Off, Output = 0
2.   LED 1 = top left pushbutton, LED 2 = A/M pushbutton, LED 3 = bottom left pushbutton
     LED 4 = R/L pushbutton, LED 5 = middle left LED, LED 6 = middle right LED
```

F100 [TTRIP] TOUT Fault Status

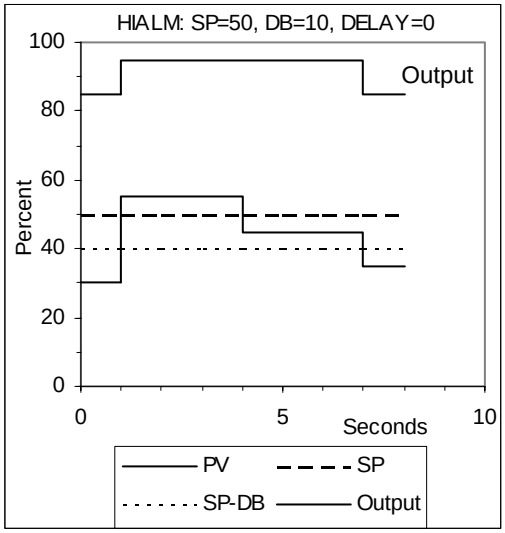
Function **TTRIP** indicates the current Fault status of a particular **TOUT** Block. The **TTRIP** Block Output = 1 if the monitored **TOUT** Block has detected a Fault, and the Block Output = 0 when no Faults are present. The analog Input to the **TTRIP** Block is a dummy Input that is used to indicate which **TOUT** Output Block is to be monitored.

See F83 **TOUT** for details on the Fault Detection logic in the **TOUT** block that drives the **TTRIP** Block output.

TTRIP will remain active for at least 5 seconds. This Block is primarily used to activate an alarm or a safety shutdown system.

```
-------------------------------------------------------------------------------------------
FUNCTION:  100          TEMP BYTES:   0     RETENTIVE BYTES:   0        DATA BYTES:   4
NAME:      TTRIP                     SINGLE USE FUNCTION:   N       OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type          Description                                            Notes
_____________________________________________________________________________________
  1        A       TOUT BLOCK TO BE MONITORED                                 1

No Parameters

Notes:
1. The BLOCK TO BE MONITORED must be a TOUT Block.
```

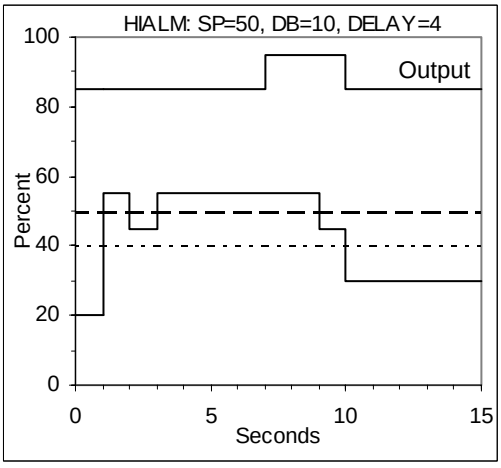
F101 [HIALM] High Alarm



Function **HIALM** compares the PV (Process Variable) Input to the SP (Setpoint) and changes the Block Output to a "1" when PV > SP. If **HIALM** is connected to the **PANEL** Block, or directly to an **ROUT**, **DOUT**, or **TOUT** Block, it can trigger audible/visual alarms. **HIALM** can also be used as a trigger in Blockware to automate a control strategy. Example: Trigger an **ASW** to select **PID** "B" instead of **PID** "A", when steam flow exceeds 20%. See top figure at right

Inputs 2-3, and Parameters 1-5 modify the basic behavior as follows:

Deadband or Hysterisis (Parameter 2): When Deadband (DB)= 0.0: Output = 1, if PV > SP; or Output = 0, if PV =< SP. When Deadband > 0: Output = 1, if PV > SP; and once the Output becomes a 1, it remains a 1 until PV < (SP - DB) and then it resets to 0.



Internal vs External Setpoint (Parameters 1 and 3, and Input 2): By default, Parameter 1 = 2, and **HIALM** uses the INTERNAL SETPOINT stored in Parameter 3 as the SP. Changing Parameter 1 to "1", causes **HIALM** to use the EXT SP (External Setpoint) Input (Input 2) as the SP.

In EXT SP mode: A **FPCON** (F55) Input to EXT SP allows the Operator to adjust an alarm setpoint from the front panel Process mode display channels, and **FPCON**'s Min/Max parameters can limit the range of adjustment. If the **PID** setpoint **FPCON** Block feeds a **WSUM** (F52) Block, and **WSUM** connects to the EXT SP, the **HIALM** setpoint can be a constant percentage above the Operator adjusted **PID** setpoint .

Alarm Time Delay (Parameter 5): PV must be continuously greater than SP for (Parameter 5) seconds before the **HIALM** Block Output will change to a "1". See bottom figure at right.

Alarm Disable (Parameter 4, and Input 3): By default, **HIALM** is Enabled and responds to alarms because the defaults are: Input 3 is Block 2 (**D0** or Low), and Alarm Disable is ACTIVE HI (Parameter 4 = 1). However, Blockware can use the Disable Input (Input 3) to selectively Disable individual alarm Blocks, that is force the alarm Block Output to be a "0". Parameter 4 determines if the Disable signal is "Active HI", or "Active LO" as follows:

Parameter 4	Disable Input	Mode
1 (Active HI)	0	Enabled
1 (Active HI)	1	Disabled
0 (Active LO)	0	Disabled
0 (Active LO)	1	Enabled

FUNCTION: 101	TEMP BYTES: 0	RETENTIVE BYTES: 0	DATA BYTES: 32
NAME: HIALM	SINGLE USE FUNCTION: N	OUTPUT TYPE: D	

Input	Type	Description	Notes
1	A	PV INPUT	
2	A	EXT SP INPUT (Optional)	1
3	D	DISABLE INPUT	2

Parameter	Description	Default	Max	Min	Code	Notes
1	SP MODE 1=EXT 2=INT	2	2	1	2	1
2	% DEADBAND	0.20	100.00	0.00	1	3
3	% INTERNAL SETPOINT	50.00	199.99	-199.99	1	1
4	ALARM DISABLE ACTIVE LO/HI 0=LO, 1=HI	1	1	0	2	2
5	ALARM DELAY SECONDS	0	600	0	1	4

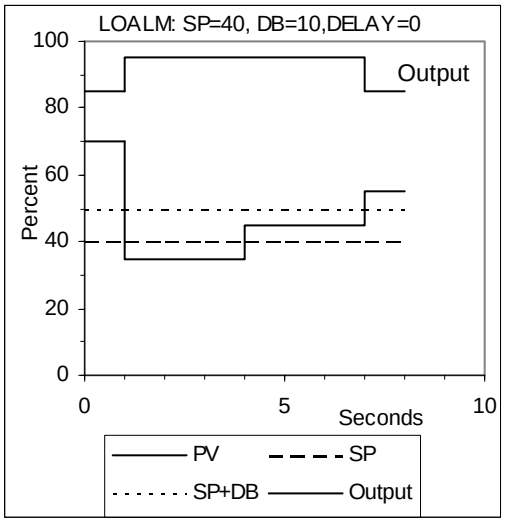
Notes:
1. See "Internal vs External Setpoint" above.
2. See "Alarm Disable" above.
3. See "Deadband" above.
4. See "Alarm Time Delay" above.

F102 [LOALM] Low Alarm

Function **LOALM** compares the PV (Process Variable) Input to the SP (Setpoint) and changes the Block Output to a "1" when PV < SP. If **LOALM** is connected to the **PANEL** Block, or directly to an **ROUT**, **DOUT**, or **TOUT** Block, it can trigger audible/visual alarms for the Operator. **LOALM** can also be used as a trigger in Blockware to automate a control strategy. See figure.

Deadband or Hysterisis (Parameter 2): When Deadband (DB)= 0.0: Output = 1, if PV < SP; Output = 0, if PV >= SP. When Deadband > 0: Output = 1, if PV < SP; and once the Output becomes a 1, it remains a 1 until PV > (SP + DB) and then it resets to 0. See figure at right.

See **HIALM** (F101) above for details on Inputs 2-3, and Parameters 1, and 3-5.



FUNCTION: 102	TEMP BYTES: 0	RETENTIVE BYTES: 0	DATA BYTES: 32
NAME: LOALM	SINGLE USE FUNCTION: N	OUTPUT TYPE: D	

Input	Type	Description	Notes
1	A	PV INPUT	
2	A	EXT SP INPUT	1
3	D	DISABLE INPUT	1

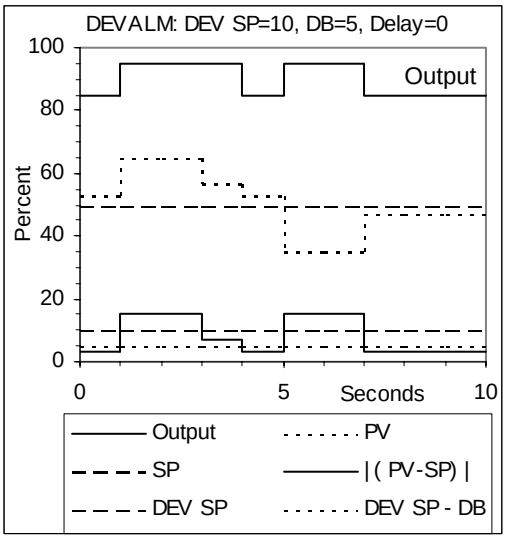
Parameter	Description	Default	Max	Min	Code	Notes
1	SP MODE 1=EXT 2=INT	2	2	1	2	1
2	% DEADBAND	0.20	100.00	0.00	1	3
3	% INT SP	50.00	199.99	-199.99	1	1
4	ALARM DISABLE ACTIVE LO/HI 0=LO, 1=HI	1	1	0	2	2
5	ALARM DELAY SECONDS	0	600	0	1	4

Notes:
1. See "Internal vs External Setpoint" in HIALM (F101) above.

Notes:

2. See "Alarm Disable" in HIALM (F101) above.
3. See "Deadband" above.
4. See "Alarm Time Delay" in HIALM (F101) above.

F103 [DEVALM] Deviation Alarm



Function **DEVALM** subtracts the PV (Process Variable) Input from the SP (Setpoint) and changes the Block Output to a "1" if the absolute value of the difference is greater than the allowable Deviation (Parameter 2). Or, in equation form:

If |(PV-SP)| > Deviation Then Block Output = "1"

Note: "| (PV-SP) |" means:
If (PV-SP) is negative, multiply by -1

If **DEVALM** is connected to the **PANEL** Block, or directly to an **ROUT**, **DOUT**, or **TOUT** Block, it can trigger audible/visual alarms for the Operator. **DEVALM** can also be used as a trigger in Blockware to automate a control strategy.

Inputs 2-3, and Parameters 1, and 3-7 modify the basic behavior as follows:

Deadband or Hysterisis (Parameter 3): When Deadband (DB)= 0.0: Output = 1, if |(PV-SP)| > Deviation, or Output = 0, if |(PV-SP)| =< Deviation. When Deadband > 0: Output = 1, if |(PV-SP)| > Deviation, and once the Output becomes a 1, it remains a 1 until [|(PV-SP)| < (Deviation – DB)] and then it resets to 0. See figure above.

Internal vs External Setpoint (Parameters 1 and 4, and Input 2): By default, Parameter 1 = 1, and **DEVALM** uses the EXT SP (External Setpoint) Input (Input 2) as the SP. Changing Parameter 1 to "2", causes **DEVALM** to use the INTERNAL SETPOINT stored in Parameter 4 as the SP.

Alarm Time Delay (Parameter 7): |(PV-SP)| must be continuously greater than the % Deviation threshold for (Parameter 7) seconds before the **DEVALM** Block Output will change to a "1".

Alarm Disable (Parameter 5, and Input 3): By default, **DEVALM** is Enabled and responds to alarms because the defaults are: Input 2 is Block 2 (**D0** or Low), and Alarm Disable is ACTIVE HI (Parameter 5 = 1). However, Blockware can use the Disable Input (Input 3) to selectively Disable individual alarm Blocks; that is, force the alarm Block Output to be a "0". Parameter 5 determines if the Disable signal is "Active HI", or "Active LO" as follows:

Parameter 5	Disable Input	Mode
1 (Active HI)	0	Enabled
1 (Active HI)	1	Disabled
0 (Active LO)	0	Disabled
0 (Active LO)	1	Enabled

Inverted Output (Parameter 6): When Parameter 6 = 1, The Block Output is opposite the normal value. Or, when INVERTED = "1", Output = "1" if |(PV-SP)| < Deviation.

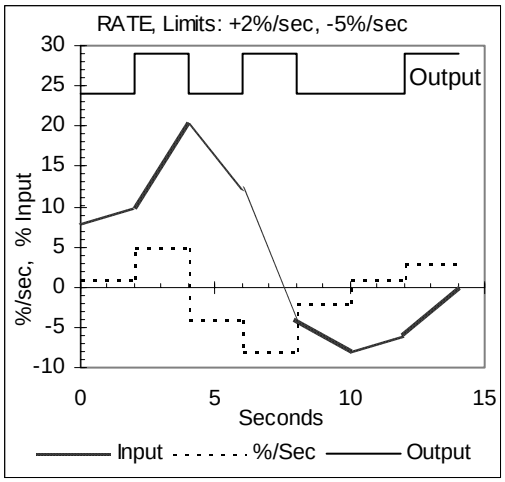
FUNCTION: 103	TEMP BYTES: 0	RETENTIVE BYTES: 0	DATA BYTES: 40
NAME: DEVALM		SINGLE USE FUNCTION: N	OUTPUT TYPE: D

Input	Type	Description	Notes
1	A	PV INPUT	
2	A	EXT SP INPUT	1
3	D	DISABLE INPUT	2

Parameter	Description	Default	Max	Min	Code	Notes
1	SP MODE 1=EXT 2=INT	1	2	1	2	1
2	% DEVIATION THRESHOLD	2.00	199.99	0.10	1	
3	% DEADBAND	0.10	100.00	0.00	1	3
4	% INT SP	50.00	199.99	-199.99	1	1
5	ALARM DISABLE ACTIVE LO/HI 0=LO, 1=HI	1	1	0	2	2
6	INVERT OUTPUT 0=NO 1=YES	0	1	0	2	5
7	ALARM DELAY SECONDS	0	600	0	1	4

Notes:
1. **See "Internal vs External Setpoint" above.**
2. **See "Alarm Disable" above.**
3. **See "Deadband" above.**
4. **See "Alarm Time Delay" above.**
5. **See "Inverted Output" above**

F104 [RATE] Rate of Change Alarm



Function **RATE** calculates the % per second (%/sec) rate of change of the Input signal every scan. **RATE** also saves the %/sec values from the previous 5 scans in memory. **RATE** then computes the average %/sec rate of change over the last 5 scans, and compares the average to the two alarm thresholds in Parameters 1 and 2.

Alarm Time Delay (Parameter 4): If the average %/sec rate exceeds either threshold continuously for more than (Parameter 5) seconds, the **RATE** Output changes to a "1". As soon as the average %/sec rate returns below both thresholds, the **RATE** Output returns to a "0". See Figure.

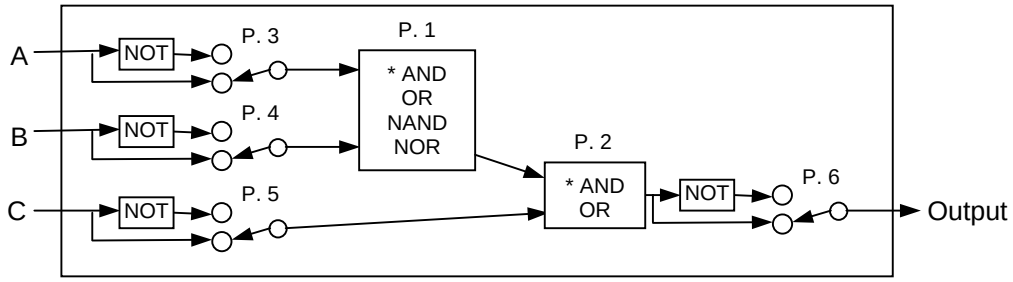
Alarm Disable (Parameter 3, and Input 2): By default, **RATE** is Enabled and responds to alarms because the defaults are: Input 3 is Block 2 (**D0** or Low), and Alarm Disable is ACTIVE HI (Parameter 3 = 1). However, Blockware can use the Disable Input (Input 2) to selectively Disable individual alarm Blocks; that is, force the alarm Block Output to be a "0". Parameter 3 determines if the Disable signal is "Active HI", or "Active LO" as follows:

Parameter 3	Disable Input	Mode
1 (Active HI)	0	Enabled
1 (Active HI)	1	Disabled
0 (Active LO)	0	Disabled
0 (Active LO)	1	Enabled

```
-------------------------------------------------------------------------------------------
FUNCTION:  104          TEMP BYTES:   4      RETENTIVE BYTES:   0         DATA BYTES:  24
NAME:      RATE                        SINGLE USE FUNCTION:   N        OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type           Description                                              Notes
___________________________________________________________________________________________

  1        A       INPUT
  2        D       DISABLE INPUT                                                  1

Parameter          Description                 Default     Max       Min        Code   Notes
___________________________________________________________________________________________

  1           + % /SEC LIMIT                    10.0      100.0      0.1         1
  2           - % /SEC LIMIT                   -10.0       -0.1   -100.0        1
  3           ALARM DISABLE ACTIVE LO/HI
                 0=LO, 1=HI                      1          1         0          2      1
  4           ALARM DELAY SECONDS               0        600         0          1      2
Notes:
1.   See "Alarm Disable" above.
2.   See "Alarm Time Delay" above.
```

F107 [LOGIC] User Defined Logic

Function **LOGIC** provides user configurable binary logic for up to three discrete Inputs. Parameters 3-6 allow negating any Input or the Block Output. Parameter 1 selects the logical function used to combine Inputs A and B. Parameter 2 selects the logical function used to combine Input C with the result of A and B. See figure below.



If only two Inputs are used: Connect Inputs A and B, leave Input C connected to the default Block 2 (D0), and change Parameter 2 to a "2" (OR logic).

Inputs:

A	B
0	0
0	1
1	0
1	1

Result for each logical function:

AND	OR	NAND	NOR
0	0	1	1
0	1	1	0
0	1	1	0
1	1	0	0

```
-------------------------------------------------------------------------
FUNCTION:  107          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:  36
NAME:      LOGIC                        SINGLE USE FUNCTION:   N        OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type           Description                                            Notes
___________________________________________________________________________________________

  1        D       A INPUT
  2        D       B INPUT
  3        D       C INPUT

Parameter          Description                 Default     Max       Min        Code   Notes
___________________________________________________________________________________________

  1           A-B LOGIC  1=AND 2=OR 3=NAND
                 4=NOR                           1         4         1          2
  2           (AB) - C LOGIC  1=AND 2=OR         1         2         1          2
  3           INVERT INPUT A 0=NO 1=YES          0         1         0          2
  4           INVERT INPUT B 0=NO 1=YES          0         1         0          2
  5           INVERT INPUT C 0=NO 1=YES          0         1         0          2
  6           INVERT OUTPUT 0=NO 1=YES           0         1         0          2
```

F110 [XOR] Exclusive OR Logic

Function **XOR** calculates the "Exclusive OR" logical function for two discrete Inputs. XOR means If ONLY one Input is True (Exclusively), Then the Output is True. See Truth Table:

Inputs:

A	B
0	0
0	1
1	0
1	1

Result:

XOR
0
1
1
0

```
-------------------------------------------------------------------------------------------
FUNCTION:  110          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:  12
NAME:      XOR                          SINGLE USE FUNCTION:   N        OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type           Description                                            Notes
___________________________________________________________________________________________

  1        D       A INPUT
  2        D       B INPUT

Parameter          Description                 Default     Max       Min        Code   Notes
___________________________________________________________________________________________

  1           INVERT OUTPUT? 0=NO 1=YES          0         1         0          2
```

F111 [NOT] NOT Logic

Function **NOT** logically inverts (ie negates) the Block Input.

```
-------------------------------------------------------------------------------------------
FUNCTION:  111          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:   4
NAME:      NOT                          SINGLE USE FUNCTION:   N        OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type           Description                                            Notes
___________________________________________________________________________________________

  1        D       INPUT BLOCK

No Parameters
```

F112 [F/F] Flip Flop Logic

Function **F/F** behaves like a Latch relay. The Block Output remains at it's last value (1 or 0) unless one of the three Inputs is activated. The Block Output behaves according to the table below:

Parameter 1 Inverted Output	Set	Reset	Toggle	Output
0 = No	1	0	X	1
0 = No	0	1	X	0
1 = Yes	1	0	X	0
1 = Yes	0	1	X	1
X	1	1	X	No change, same value from previous scan
X	0	0	^1	Opposite the Output value from the previous scan. 0 becomes 1, 1 becomes 0
X	0	0	0, 1, or 1 -> 0	No change, same value from previous scan

X means: not used, can be any value
^1 means: on the rising edge (i.e., only once during the scan that the Input changes from 0 to 1)

The Set and Reset Inputs have priority over the Toggle Input; that is, the Toggle Input is ignored unless both the Set and Reset Inputs = 0. When Set = Reset = 1, the Block Output does not change, and the Toggle Input is ignored. The Toggle Input is only active for the single scan after the Toggle Input changes from 0 to 1, and Set = Reset = 0.

At power down, the **F/F** Block Output is saved in the Retentive Memory area of the EEPROM. During the first scan after CPU start-up, the **F/F** Block Output is set according to Parameter 2. "LAST" means: use the value saved in Retentive Memory.

```
-------------------------------------------------------------------------------------------
FUNCTION:  112          TEMP BYTES:   0      RETENTIVE BYTES:   1         DATA BYTES:  20
NAME:      F/F                          SINGLE USE FUNCTION:   N        OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type           Description                                            Notes
_____________________________________________________________________________________
  1        D       SET INPUT
  2        D       TOGGLE INPUT
  3        D       RESET INPUT

Parameter          Description                 Default     Max       Min        Code   Notes
_____________________________________________________________________________________
  1           INVERT OUTPUT 0=NO 1=YES           0         1         0          2
  2           POWER UP 1=HI 2=LO 3=LAST          3         3         1          2
```

F116 [TOT] Totalizer (Integrator with Pulse Output)

Function **TOT** is a signal integrator with a scaled pulse Output. The primary application of the **TOT** Block is to drive a counter for flow totalization. **TOT** can connect to a **DOUT**, **TOUT**, or **ROUT** Block to drive an external physical counter. **TOT** can also be connected to a **COUNT** Block, and the **COUNT** Block Output can be displayed via the **PANEL** Block.

100% Input Counts/Hr (Parameter 2) determines the **TOT** Output pulse scaling as follows: If the Input is a constant 100%, Then **TOT** produces (Parameter 2) Pulses (or Counts) per hour. The **TOT** Block Output is normally "0", each Block Output pulse is a "1" for exactly one scan. Example: If the **TOT** Input is a 0-100% signal from a steam flow meter that is calibrated for 0-75,000 lb/hr steam flow, set Parameter 2 to "7500" to make every pulse equivalent to 10 lbs of steam.

Input Cutoff % (Parameter 1): The calibration of some flowmeters tend to drift near 4 mA (0%). This can cause false flow totalization when there is actually no flow. Inputs less than (Parameter 1) are ignored, and no pulse Outputs are generated. Negative Inputs do not generate a pulse Output.

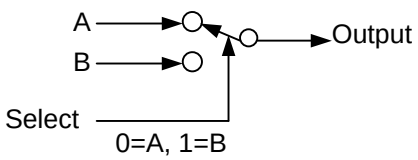
Disable Input (Parameter 3, and Input 2): By default, **TOT** is Enabled and totalizes because the defaults are: Input 2 is Block 2 (**D0** or Low), and Alarm Disable is ACTIVE HI (Parameter 3 = 1). However, Blockware can use the Disable Input (Input 2) to selectively Disable totalization, that is force the **TOT** Block Output to be a "0". Parameter 3 determines if the Disable signal is "Active HI", or "Active LO" as follows:

Parameter 3	Disable Input	Mode
1 (Active HI)	0	Enabled
1 (Active HI)	1	Disabled
0 (Active LO)	0	Disabled
0 (Active LO)	1	Enabled

```
-------------------------------------------------------------------------------------------
FUNCTION:  116          TEMP BYTES:   4      RETENTIVE BYTES:   0         DATA BYTES:  24
NAME:      TOT                           SINGLE USE FUNCTION:   N        OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type           Description                                              Notes
___________________________________________________________________________________________

  1        A       INPUT BLOCK
  2        D       DISABLE BLOCK

Parameter          Description                 Default     Max       Min        Code   Notes
___________________________________________________________________________________________

  1           INPUT CUTOFF %                     0.00    100.00     0.00        2
  2           100% INPUT COUNTS/HOUR          1000     18000       60          2
  3           DISABLE INPUT ACTIVE LO/HI:
                 0=LO, 1=HI                      1         1         0          2
```

F117 [DSW] Discrete Switch

Function **DSW** is used to switch the Block Output between one of two discrete Input signals under control of a discrete Select signal. The concept is very similar to a SPDT relay or 3 port solenoid valve. When the Select signal is "0" the A Input is selected and passed to the **DSW** Block Output. When Select = "1", the “B” signal is passed to the Output. The Block Output changes instantaneously when the Select Input changes.

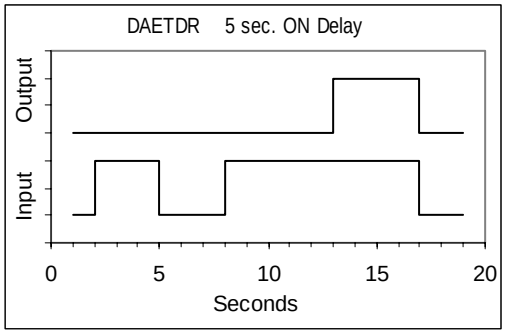



```
-------------------------------------------------------------------------------------------
FUNCTION:  117          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:  12
NAME:      DSW                           SINGLE USE FUNCTION:   N        OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type           Description                                              Notes
___________________________________________________________________________________________

  1        D       A INPUT
  2        D       B INPUT
  3        D       SELECT INPUT (0 = A, 1 = B)

No Parameters
```

F118 [DAETDR] Delay After Energize Time Delay Relay (On Delay)

Function **DAETDR** simulates a "Delay After Energize" Time Delay Relay, also known as an "ON Delay" function. The Output may be inverted, see Parameter 2. The timing diagram shows the default, non-inverted logic.

For non-Inverted Output: When the Input = "0", the Output is "0", and the timer is reset to (Parameter 1) seconds. When the Input = "1", the timer starts counting down, and the Output changes to "1" when the timer counts down to 0 seconds.

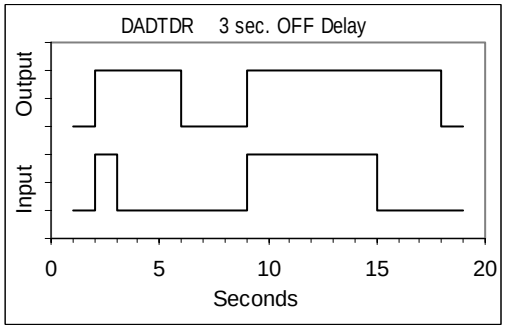



```
-------------------------------------------
-------------------------------------------
FUNCTION:  118          TEMP BYTES:   4      RETENTIVE BYTES:   0        DATA BYTES:  12
NAME:      DAETDR                        SINGLE USE FUNCTION:   N       OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type           Description                                          Notes
-------------------------------------------------------------------------------------------
  1        D       INPUT

Parameter          Description                 Default     Max       Min        Code   Notes
-------------------------------------------------------------------------------------------
  1           SECONDS DELAY                      1      19999        1          2
  2           INVERT OUTPUT 0=NO 1=YES           0         1         0          2
```

F119 [DADTDR] Delay After De-energize Time Delay Relay (Off Delay)

Function **DADTDR** simulates a "Delay After De-energize" Time Delay Relay, also known as an "OFF Delay" function. The Output may be inverted, see Parameter 2. The timing diagram shows the default, non-inverted logic.

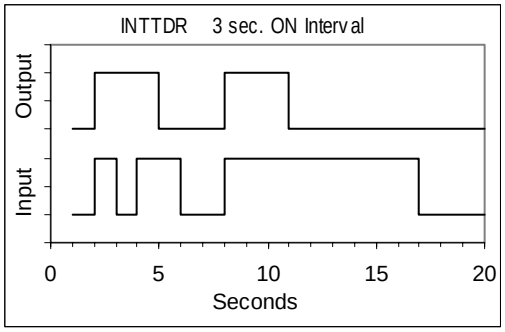
For non-Inverted Output: When the Input = "1", the Output is "1", and the timer is reset to (Parameter 1) seconds. When the Input changes from "1" to "0", the timer starts counting down, and the Output changes to "0" when the timer counts down to 0 seconds.




```
-------------------------------------------
-------------------------------------------
FUNCTION:  119          TEMP BYTES:   4      RETENTIVE BYTES:   0        DATA BYTES:  12
NAME:      DADTDR                        SINGLE USE FUNCTION:   N       OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type           Description                                          Notes
-------------------------------------------------------------------------------------------
  1        D       INPUT

Parameter          Description                 Default     Max       Min        Code   Notes
-------------------------------------------------------------------------------------------
  1           SECONDS DELAY                      1      19999        1          2
  2           INVERT OUTPUT 0=NO 1=YES           0         1         0          2
```

F120 [INTTDR] Interval Time Delay Relay (Non-Retriggerable One Shot)

Function **INTTDR** simulates a "Interval" Time Delay Relay, also known as an "Non-Retriggerable One Shot" function. The Output may be inverted (see Parameter 2). The timing diagram shows the default, non-inverted logic.



For non-Inverted Output: When the **INTTDR** Output is "0", the timer is reset to (Parameter 1) seconds. When the **INTTDR** Input changes from a "0" in the previous scan to a "1" in the current scan, the timer starts counting down, and the Output changes to "1". When the Timer counts down to 0, the Output changes to "0". While the timer is counting down, the Input is ignored and has no effect on the timer or Output.

If the Delay Seconds is set to 0 seconds, the **INTTDR** Output will be "1" for exactly one scan.

FUNCTION: 120	TEMP BYTES: 8	RETENTIVE BYTES: 0	DATA BYTES: 12
NAME: INTTDR		SINGLE USE FUNCTION: N	OUTPUT TYPE: D

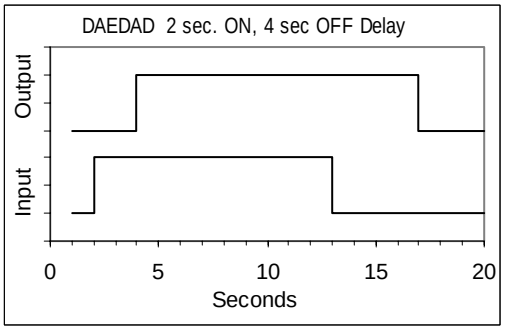
Input	Type	Description	Notes
1	D	INPUT	1

Parameter	Description	Default	Max	Min	Code	Notes
1	SECONDS DELAY (0=1 SCAN)	1	19999	0	2	2
2	INVERT OUTPUT 0=NO 1=YES	0	1	0	2	

Notes:
1. **An Input transition from 0 to 1 starts the timing sequence.**
2. **Delay Seconds = 0 means the Output will go active for exactly one scan and then return to the inactive Output state.**

F121 [DAE/DAD] Delay After Energize / Delay After De-energize Timer

Function **DAE/DAD** combines **DAETDR** (F118) and **DADTDR** (F119) into a single function. **DAE/DAD** behaves as though the Output of a **DAETDR** Block was the Input to a **DADTDR** Block. **DAE/DAD** provides an initial ON Delay, and then provides an OFF Delay when the Input returns to "0". The Output may be inverted, see Parameter 3. The timing diagram shows the default, non-inverted logic.



For non-Inverted Output: When the **DAE/DAD** Output is "0" AND the Input is "0": the ON and OFF timers are reset to (Parameter 1) and (Parameter 2) seconds, respectively. When the Input = "1", the ON Delay timer starts counting down, and the Output changes to "1" when the ON Delay timer counts down to 0 seconds.

When the **DAE/DAD** Output is "1", and the Input changes from "1" to "0", the OFF Delay timer starts counting down, and the Output changes to "0" when the timer counts down to 0 seconds. If the Input changes back to "1" while the Output is still "1", the OFF Delay timer is reset.

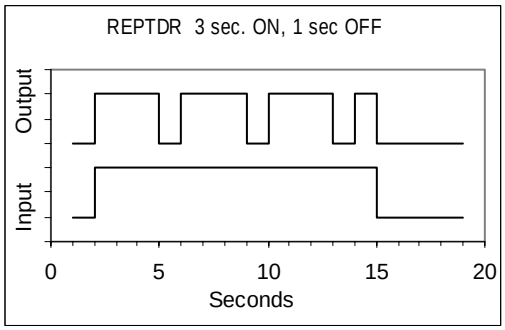
FUNCTION: 121	TEMP BYTES: 12	RETENTIVE BYTES: 0	DATA BYTES: 16
NAME: DAE/DAD		SINGLE USE FUNCTION: N	OUTPUT TYPE: D

Input	Type	Description	Notes
1	D	INPUT	

Parameter	Description	Default	Max	Min	Code	Notes
1	ON DELAY SECONDS	1	19999	1	2	
2	OFF DELAY SECONDS	1	19999	1	2	
3	INVERT OUTPUT 0=NO 1=YES	0	1	0	2	

F122 [REPTDR] Repeat Time Delay Relay

Function **REPTDR** provides repetitive Block Output cycling (1, 0, 1, 0, …) with defined ON and OFF times. The Output may be inverted, see Parameter 2. The timing diagram shows the default, non-inverted logic.



For non-Inverted Output: When the Input is "0", the Output is "0", and both ON and OFF timers reset. When the Input changes from "0" to "1", the Output changes to "1", and the ON timer starts (Parameter 1). If the Input is still "1", and the ON timer times out: the Output changes to "0", the OFF timer starts, and the ON timer resets. If the Input is still "1", the Output changes to "1" and the cycle repeats until the Input changes to "0".

FUNCTION: 122	TEMP BYTES: 8	RETENTIVE BYTES: 0	DATA BYTES: 16
NAME: REPTDR		SINGLE USE FUNCTION: N	OUTPUT TYPE: D

Input	Type	Description	Notes
1	D	INPUT	

Parameter	Description	Default	Max	Min	Code	Notes
1	ON TIME SECONDS	1	19999	1	2	
2	OFF TIME SECONDS	1	19999	1	2	
3	INVERT OUTPUT 0=NO 1=YES	0	1	0	2	

F123 [COMM] RS485 Communications Link Control

Function **COMM** and Function **PLINK** both provide Communications Link (Comm Link) status and control the ability of the Comm Link to write (modify) PCC III Block Outputs and parameters. **COMM** and **PLINK** are mutually exclusive (ie, only one of these two functions can be used within a PCC III configuration). Neither Block is required if the Comm Link does not have to write (modify) to any Block Outputs or parameters (ie, the Comm Link will be read-only).

If the Comm Link only writes to (ie modifies) Block Outputs, but not Block parameters, the **COMM** function may be used. If the Comm Link writes to Block parameters, the **PLINK** function must be used. **COMM** has no parameters and thus consumes negligible memory, while **PLINK** consumes a considerable amount of memory.

The Block Output is "1" if RS485 communications is enabled (See Section 7), and a valid message addressed to this particular PCC III has been received within the Communications Time Out period. The TIME OUT seconds are set in the COM MENU \ TIME OUT Edit Menus, See Sections 4 and 7.

Remote/Local (R/L) Input: When the R/L Input is "1" (Remote), the Comm Link is allowed to write (modify) FPT/H (F38), FPCON (F55), PB (F98), RAIN (F5), and RDIN (F97) Block Outputs. In Remote mode, the Operator can also modify from the PCC III front panel the FPT/H, FPCON, or PB Blocks.

When the R/L Input is "0" (Local), the Comm Link can not modify FPT/H, FPCON, or PB Blocks. However, Comm Link can write to RAIN and RDIN Blocks in Local mode.

At power up, If RS485 is Enabled in the COM MENU, **COM** Block Output ="1". The Time Out count down re-starts at power up.

```
-------------------------------------------------------------------------------------------
FUNCTION:  123          TEMP BYTES:   0      RETENTIVE BYTES:   0         DATA BYTES:   4
NAME:      COMM                        SINGLE USE FUNCTION:   Y        OUTPUT TYPE:   D
-------------------------------------------------------------------------------------------
Input    Type           Description                                              Notes
_____________________________________________________________________________________
  1        D       REMOTE\LOCAL BLOCK (1=REMOTE WRITES ENABLED, 0=LOCAL ONLY)

No Parameters
```

F124 [PLINK] Block Parameter Links for Communications

Function **PLINK** provides all of the features of **COMM** (F123) described above, and adds the feature of allowing Comm Link to read or write Parameters into individual Blocks. Without **PLINK**, Comm Link can only read and write PCC III Block Outputs.

PLINK allows the Blockware designer to assign up to 30 different individual Block Parameters to the Modbus Holding Register addresses 41001 thru 41030. The assignments do not have to be in any particular order, and register addresses may be skipped if desired.

Example: To allow **PID** tuning from a workstation, configure **PLINK** to "map" the **PID** Gain and **PID** Repeats/Min Parameters to two Modbus Holding Register addresses. Pick any two available Registers: 41003 for Gain, and 41004 for Repeats/Min in this Example. Consult the **PID** description above (Section 6) to determine that Gain is Parameter 1, and Repeats/Min is Parameter 2. Assume for this Example that **PID** is in Block number 32. The **PLINK** Parameters should be configured as follows:

PLINK Parameter	**PLINK** Parameter Description	**PLINK** Parameter Value	Comment
5	R41003 Block Number	32	**PID** Block Number
6	R41003 Parameter Number	1	**PID** Gain Parameter Number
7	R41004 Block Number	32	**PID** Block Number
8	R41004 Parameter Number	2	**PID** Repeats/Min Parameter Number

Values are reported to the RS485 Comm Link as 16 bit signed integers. The assumed decimal point location, that is the scaling, of each parameter is determined by consulting the parameter description min/max values shown in each of the function descriptions above (Section 6). Some Examples:

Function **F(T)** (F41) shows Parameter 2 with -150.00 to +150.00 min/max values.
A value of -110.05 would be transmitted via RS485 as: -11005.
Function **F(T)** (F41) shows Parameter 3 with 0.0 to 1999.9 min/max values.
A value of 60.0 minutes would be transmitted via RS485 as: 600.

Indirect Addressing (Advanced Users): **PLINK** can modify it's own Parameters to allow a remote Workstation access to ALL of the Parameters in ALL Blocks without configuring the desired **PLINK** register in advance. Example: Assign Register 41001 to **PLINK** Parameter 5, Assign Register 41002 to **PLINK** Parameter 6. Register 41001 and 41002 can now be used to assign Register 41003 to any Parameter in any Block in the PCC III.

FUNCTION: 124 TEMP BYTES: 0 RETENTIVE BYTES: 0 DATA BYTES: 244
NAME: PLINK SINGLE USE FUNCTION: Y OUTPUT TYPE: D

Input	Type	Description	Notes
1	D	REMOTE\LOCAL BLOCK	x

Parameter	Description	Default	Max	Min	Code	Notes
1	R41001 BLOCK	3	159	3	2	1
2	R41001 PARAMETER	1	70	1	2	
3	R41002 BLOCK	3	159	3	2	1
4	R41002 PARAMETER	1	70	1	2	
5	R41003 BLOCK	3	159	3	2	1
6	R41003 PARAMETER	1	70	1	2	
7	R41004 BLOCK	3	159	3	2	1
8	R41004 PARAMETER	1	70	1	2	
9	R41005 BLOCK	3	159	3	2	1
10	R41005 PARAMETER	1	70	1	2	
11	R41006 BLOCK	3	159	3	2	1
12	R41006 PARAMETER	1	70	1	2	
13	R41007 BLOCK	3	159	3	2	1
14	R41007 PARAMETER	1	70	1	2	
15	R41008 BLOCK	3	159	3	2	1
16	R41008 PARAMETER	1	70	1	2	
17	R41009 BLOCK	3	159	3	2	1
18	R41009 PARAMETER	1	70	1	2	
19	R41010 BLOCK	3	159	3	2	1
20	R41010 PARAMETER	1	70	1	2	
21	R410011 BLOCK	3	159	3	2	1
22	R410011 PARAMETER	1	70	1	2	
23	R41012 BLOCK	3	159	3	2	1
24	R41012 PARAMETER	1	70	1	2	
25	R41013 BLOCK	3	159	3	2	1
26	R41013 PARAMETER	1	70	1	2	
27	R41014 BLOCK	3	159	3	2	1
28	R41014 PARAMETER	1	70	1	2	
29	R41015 BLOCK	3	159	3	2	1
30	R41015 PARAMETER	1	70	1	2	
31	R41016 BLOCK	3	159	3	2	1
32	R41016 PARAMETER	1	70	1	2	
33	R41017 BLOCK	3	159	3	2	1
34	R41017 PARAMETER	1	70	1	2	
35	R41018 BLOCK	3	159	3	2	1
36	R41018 PARAMETER	1	70	1	2	
37	R41019 BLOCK	3	159	3	2	1
38	R41019 PARAMETER	1	70	1	2	
39	R41020 BLOCK	3	159	3	2	1
40	R41020 PARAMETER	1	70	1	2	
41	R41021 BLOCK	3	159	3	2	1

42	R41021 PARAMETER	1	70	1	2	
43	R41022 BLOCK	3	159	3	2	1
44	R41022 PARAMETER	1	70	1	2	
45	R41023 BLOCK	3	159	3	2	1
46	R41023 PARAMETER	1	70	1	2	
47	R41024 BLOCK	3	159	3	2	1
48	R41024 PARAMETER	1	70	1	2	
49	R41025 BLOCK	3	159	3	2	1
50	R41025 PARAMETER	1	70	1	2	
51	R41026 BLOCK	3	159	3	2	1
52	R41026 PARAMETER	1	70	1	2	
53	R41027 BLOCK	3	159	3	2	1
54	R41027 PARAMETER	1	70	1	2	
55	R41028 BLOCK	3	159	3	2	1
56	R41028 PARAMETER	1	70	1	2	
57	R41029 BLOCK	3	159	3	2	1
58	R41029 PARAMETER	1	70	1	2	
59	R41030 BLOCK	3	159	3	2	1
60	R41030 PARAMETER	1	70	1	2	

Note
1. Assigning Block 3 (D1) to any register, disables the register. If a disabled register is the first register in a multiple register read or write command, a bad address error is returned. Disabled registers in the middle of a multiple register read request will return a value of 0.

F125 [ROUT] Relay Output

Function **ROUT** is the Blockware interface to the PCC III Relay Output hardware. **ROUT** interfaces to Relay Outputs on the CPU board, and on option boards. Parameter 1 specifies the board location (the CPU board = board 0). Parameter 2 selects a particular Relay on the specified board.

Invert Input: By default, a "1" Input energizes the Relay and changes the Output to a "1". If Parameter 3 is changed to a "1", a "0" Input Energizes the Relay and the Block Output.

FUNCTION:	**125**	**TEMP BYTES:**	**0**	**RETENTIVE BYTES:**	**0**	**DATA BYTES: 16**
NAME:	**ROUT**			**SINGLE USE FUNCTION:**	**N**	**OUTPUT TYPE: D**

Input	Type	Description	Notes
1	D	INPUT BLOCK	1

Parameter	Description	Default	Max	Min	Code	Notes
1	OPTION BOARD (0=CPU BOARD)	0	2	0	3	
2	OUTPUT CHANNEL	1	2	1	3	
3	INVERT INPUT? 0=NO 1=YES	0	1	0	2	1

Notes:
1. See "Invert Input" above. By default, Relay energizes when Input = "1"

F126 [DOUT] Discrete Output (Open Collector - Sinking)

Function **DOUT** is the Blockware interface to the PCC III 24 Vdc Open Collector Discrete Output hardware. **DOUT** interfaces to Discrete Outputs on the CPU board, and on option boards. Parameter 1 specifies the board location (the CPU board = board 0). Parameter 2 selects a particular Discrete Output channel on the specified board.

Invert Input: By default, a "1" Input energizes the Discrete Output and changes the Output to a "1". If Parameter 3 is changed to a "1", a "0" Input Energizes the Discrete Output and the Block Output.

FUNCTION:	**126**	**TEMP BYTES:**	**0**	**RETENTIVE BYTES:**	**0**	**DATA BYTES:**	**16**
NAME:	**DOUT**			**SINGLE USE FUNCTION:**	**N**	**OUTPUT TYPE:**	**D**

Input	Type	Description	Notes
1	D	INPUT BLOCK	1

Parameter	Description	Default	Max	Min	Code	Notes
1	OPTION BOARD (0=CPU BOARD)	0	2	0	3	
2	OUTPUT CHANNEL	1	4	1	3	
3	INVERT INPUT? 0=NO 1=YES	0	1	0	2	1

Notes:
1. See "Invert Input" above. By default, Relay energizes when Input = "1"

F127 [NOP] No Operation Dummy Function

Function **NOP** does not do anything. **NOP** is the default function that is placed in all Blocks when memory is erased. A **NOP** Block is not a valid Input to any other Block, and if used as an Input would cause a "Type Mismatch" error that would prevent the controller from leaving Service Manual mode.

FUNCTION:	**127**	**TEMP BYTES:**	**0**	**RETENTIVE BYTES:**	**0**	**DATA BYTES:**	**0**
NAME:	**NOP**			**SINGLE USE FUNCTION:**	**N**	**OUTPUT TYPE:**	**D**

No Inputs and No Parameters